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THE ORIGIN OF CRIMINAL LAW.

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ANTERIOR to all regulations for the punishment or suppression of wrongs by an exercise of public authority, there was, as is generally agreed, a time when injuries found redress only through the resentment and retaliation of the injured party or his kin.

The progress of society from this rude sort of vindictive justice toward approved systems of criminal law presents some suggestive examples of the devious paths through which early communities were led to the recognition of truths which to us appear elementary. Nor is the history of this progress less intelligible or instructive to the general reader than to the professional student of the law; since it derives its interest not from its professional bearings, but from the interesting illustration which it affords of general methods of institutional development. In order to secure an accurate conception of the legal system, the early growth of which it is proposed to examine, it may be well to premise that the criminal law, which with a substantial uniformity of cardinal ideas now prevails in all civilized states, is well defined as "that branch of juridical law treating of those wrongs which the government notices as injurious to the public, and punishes by what is called a criminal proceeding, in its own name."

If it is desired to ascertain the point at which public authority began to supersede private revenge in the punishment of wrong-doers, it is worthy of observation that instances abound of tribes among whom the only offenses punishable by public authority are treason and its cognates, such as cowardice and desertion. Such was at one time the condition of the old German nations, and a similar paucity of recognized crimes is still discoverable among many of the Polynesian and American Indian tribes, and is indeed quite characteristic of un-

civilized races. On the other hand, probably no instance can be cited where public authority has been exercised in the punishment of other offenses prior to its employment against those of a treasonable nature.

Indeed, we can scarcely imagine a phase of society so primitive but that treason if committed would be so punished. The traitor deals his blow not at a particular individual but equally at every member of his community, each of whom is therefore impelled to retaliation by the same natural impulse to which he responds in avenging a personal injury. Consultation and combination among the members of the betrayed community, with a view to revenge, are then as much a matter of course as in the case of an ordinary private injury they are among the family of the injured party. But, if proceeded against only by virtue of this general sense of personal injury, treason would still be destitute of the characteristics of a true crime. It may be said with perfect accuracy that every criminal law has for its object either to preserve the existence of government or to secure the adequate discharge of its functions. Many acts involving no moral delinquency are declared crimes. Others of an immoral nature are not. The one thing that can be said without exception of every crime is this: that it is supposed to militate against either the existence or the functional efficiency of government. Given a government and a recognized governmental function, and a resort to penal sanctions in their aid must always have been an obvious necessity. The tardy growth of criminal law is to be ascribed not to a failure of primitive societies to perceive this, but to their ignorance of what the true functions of government are. That which invested treasonable offenses with the character of true crimes before other species of wrong-doing had attained that dignity was the circumstance, now well attested, that after the family and *gens* the earliest governmental organizations were offensive or defensive military confederations, entered into with sole reference to organic movement against common external foes, and not with a view to internal or police regulations. That this was so no further evidence is required than to consider on the one hand how obvious and universal an expedient, even among savages, military confederation is, and on the other by what slow and unsteady steps and circuitous paths early societies have, as will be hereafter shown, found it necessary to advance toward the conception and inauguration of a general administration of justice. The institution of governments for military purposes involved the immediate rise of those branches of criminal jurisprudence which have for their objects respectively to preserve the government and to secure the efficient discharge of its military function. There are many of the American Indian tribes among whom the exercise of public authority for the protection of the person or property of individuals from injury is unknown, who yet in times of war organize a temporary government by the election of a military chieftain whose powers within their lim-

ited sphere are absolute, and are rigorously exercised in the punishment of treason, cowardice, desertion, and military insubordination or inefficiency. This is the extent of their criminal law.

Acts of violence by one person upon the person or property of another are not punishable, since the suppression of such acts is not among the purposes for which such a government is organized. But, for the treasonable or military offenses of which they do take notice, penalties are imposed upon the true theory of criminal jurisprudence, to uphold the government or to aid its efficiency.

It is, therefore, in this class of offenses that criminal law must have had an early but meager origin under the military confederations to which the most primitive societies intuitively resort.

It might be supposed that communities thus familiarized with the punishment of crime by public authority would rapidly develop a criminal jurisprudence by the simple and direct process of adding from time to time new crimes, perhaps in the order of their supposed enormity, to their catalogue of offenses. There are some tribes so circumstanced as at first glance to countenance this view—tribes, for instance, which, while not taking cognizance of ordinary offenses, are known occasionally to prosecute notoriously hardened or habitual offenders against the persons or property of their fellows: the murderers of general favorites, obnoxious medicine-men, or persons guilty of grossly impious or sacrilegious acts, or acts involving the people in intertribal controversies.

But it will be observed that in none of these cases does the concerted action against the offenders proceed upon the notion that it is the function of government to protect its citizens against crime. It is induced in each case simply by a widely prevailing feeling of personal resentment or fear. The murderer of the popular favorite falls a victim not to any theory of government, but to the sense of individual injury and loss shared in common by all the members of the community. The habitual offender is pursued in some such spirit as that in which we shoot down a pirate; not as a violator of law, but as an acknowledged enemy of all mankind. The medicine-man, the sacrilegist, and the offender against neighboring tribes, fall victims to the terror they inspire, the one by his reputed affinity with the powers of darkness; the second by his provoking, as is supposed, an indiscriminate visitation of divine wrath; the third by subjecting all his fellows to the hostility of adjacent tribes. They are not so much punished as sacrificed: the first two to avert the wrath of Heaven; the third to appease the offended tribes. These sporadic and personally revengeful or propitiatory punishments throw little if any light on the development of the law of crimes. They are not an essential part of that movement—the most important, interesting, and difficult in the history of criminal jurisprudence—by which society abandoned its original assumption that acts of violence or fraud between individuals

are purely private grievances to be redressed by private remedies, and charged government with the function of protecting its citizens from such wrongs through proceedings conducted and punishments administered in its own name. The secret of that movement and the influence by which its progress was shaped can be gathered only from study of the antecedent practice of private retaliation. For both by its weakness and its strength the old system exercised a controlling influence over the development of the new. It was at once the chief inducement to the change and the chief obstacle to its accomplishment. In so far as public authority assumes by penal remedies to protect individuals from the criminal acts of one another, it was first called into existence, not by ordinary wrong-doing, but by an effort to restrain the abuses and excesses of retaliation as a remedial system. Its subsequent extension so as to displace the avenger and assume the punishment of wrong-doers generally was an afterthought. Thus the movement had its origin in a desire rather to mitigate punishments than to insure or increase them.

That this was true in the history of the Germanic tribes was long ago pointed out by Montesquieu with characteristic learning and ingenuity in his "Spirit of the Laws." He regarded it, however, as an experience peculiar to the Germans: to use his own language, "as contrary to the practice of all other nations." In this he was mistaken. The Germanic line of progress in criminal law, as it was pointed out by Montesquieu, instead of being unique, is substantially that which must have been pursued by all primitive communities with possibly rare and insignificant exceptions. Not only is this proposition justified by an examination of the actual processes of legal development among all races presenting the materials requisite for such an inquiry, but an analysis of the inducing causes among the Germans of this phase in their legal development will show them to have been such as were universally prevalent among mankind, and such as must have operated with remarkable uniformity.

It is to the illustration of these propositions that this paper will be mainly devoted. So far was the practice of private retaliation from being a preservative against crime, that it universally propagated more violence than it restrained. Under the most favorable circumstances, its punishments, being administered without an authoritative proceeding for the ascertainment of guilt, must frequently have fallen upon those who either were in fact, or by their relatives were thought to be, innocent. From this single infirmity of the system there must have arisen great numbers of bloody feuds, each having a tendency to propagate itself through generations. It also appears that, even in cases of acknowledged guilt, it was the custom in some communities for the family of an offender to protect him against the avenger, and to resent an attack upon him as an original injury. A family feud must then have inevitably ensued from every wrongful act of violence.

Even where the system had so far matured that the right of retaliation against a willful wrong-doer was recognized by his own family, revenge (as among the Israelites) was frequently taken on account of accidental or self-defensive acts of violence. It was a matter of course that the legitimacy of such revenge should be denied, and its exercise resented by the family upon which it was wreaked.

Again, the injured family in most instances claimed a right of revenge not only against the offending individual, but, in his absence, against any member of his family—a claim which was naturally and uniformly denied and resisted. In some societies the avenger seems to have thought it incumbent on him not only to take life for life, but to take two or more for one. Among the Congo people, according to Tuckey, if one be killed by an inferior, his family proceed to put all the male relatives of the guilty party to death. The prostitution of the practice is complete where, as among the Bushmen described by Reade, in his "Savage Africa," the stain of an injury suffered may be washed out by spilling the blood of any innocent third person, in case the guilty party is unknown or inaccessible. Superstition has occasionally operated as an additional irritant to an insane revenge. Schoolcraft relates that among some of the Dakota tribes of Indians each clan supposed the others to have supernatural powers whereby they could cause death. They hence frequently retaliated for deaths which they imagined to have been thus occasioned, though they were really due to natural causes.

From such diversities of view concerning the right of retaliation, and the justice of its application in particular instances, there inevitably ensued high carnivals of bloodshed and embroilment. While differing widely in degree among different races, the social disorder thus occasioned everywhere stood out in conspicuous contrast with that dearth of ordinary criminal acts which is characteristic of nearly all uncivilized tribes. Apart from the violence proceeding from blood-feuds, the unfrequency among such tribes of most of the acts we consider criminal is very noteworthy. The great mass of offenses, whether against person or property, which disgrace and disfigure civilization, are the product of evil passions engendered by the exasperating inequalities of condition which are unknown to the experience of uncivilized races. Of the instances of general and extreme addiction to crime which are occasionally found in the lower tribes of mankind, a few, perhaps, must be classed as exceptions to this rule, but most of them are to be explained by the fact that the races so characterized are not really primitive, but are suffering, probably in an aggravated form, from the vices of a civilization which they formerly enjoyed, or with which they have at some time come in contact.

The inducements to crime in a primitive community are too weak and public opinion is too strong to admit of the rapid growth of criminal practices. Offenses against property necessarily partake of the

scantiness of property itself. If, however, through the prevalence of an especially quarrelsome disposition in any tribe, altercations and murders increase in numbers, the far greater calamities of retaliation are aggravated in the same proportion, and, where one life is taken in original altercation, whole families and generations are consumed in retaliatory feuds.

Hence, wherever we catch glimpses of societies before they have commenced to administer a general criminal justice, we find them already busy in devising expedients for the amelioration of feuds. Tacitus, in enumerating the affairs of state transacted at the great feasts of the Germans, mentions first in the order of business "the reconcilement of enemies."

The large place occupied by blood-feuds in ancient Semitic societies and the dark shadow which they cast over social life have been vividly portrayed by Michaelis in his work on the Mosaic laws. The notoriously blightful prevalence of such feuds among the American Indians is such as to prepare us for Schoolcraft's account of a tribe to the south of Lake Superior, which he found almost extinct through intestine feuds. Indeed, such instances are by no means uncommon. A passage in which Mr. Bellew describes the condition of the feud-ridden Berdurani, or northeastern Afghan tribes, so forcibly illustrates the demoralization ensuing from feuds as to justify its quotation at length: "Indeed," he says, "the quarrelsome character of this people and the constant strife that they lead are declared by a mere glance at their villages and fields, which bristle in all directions with round towers. These are constantly occupied by men at enmity with their neighbors in the same or adjoining villages, who, perched up in their little shooting-boxes, watch the opportunity of putting a bullet into each other's body with the most persevering patience. The fields, even, are studded with these round towers, and the men holding them most jealously guard their lands from any one with whom they are at feud. Nothing belonging to their enemies is safe from their vengeance. If even a fowl strays from its owner into the grounds of another, it is sure to receive a bullet from the adversary's tower. So constant are their feuds that it is a well-known fact that the village children are taught never to walk in the center of the road, but always from force of early habit walk stealthily along under cover of the wall nearest to any tower." These, it must be conceded, are extreme cases; yet they are a perfectly logical outgrowth of unaided and unhampered private retaliation. If most nations have outgrown the system without suffering so extreme wretchedness from its prevalence among them, it is to be ascribed to the promptness and ingenuity with which they have applied themselves to its modification. Instead of being, as has been considered, a necessary though rude expedient of primitive communities for the suppression of crime, it was from the beginning and under all circumstances preëminent in its fruitfulness

of violence and disorder. It is more than doubtful whether it was either conceived or maintained with a view to the discouragement of crime. It had its origin in natural feelings of resentment, and afterward became a matter of honor. But, though vicious in its operation, the system had become so deeply rooted in the habits, the passions, the pride, the sense of honor, and the almost religious convictions of mankind, as to be among the most obstinate of institutions. Thus, among the Israelites, even after the Mosaic dispensation, the avenger was by public opinion so obligated to retaliation that in the words of Michaelis "the neglect thereof drew after it the greatest possible infamy, and subjected the man who avenged not the death of his relative to unceasing reproaches of cowardice or avarice." Among the Arabs, in the language of the same author, the avengement of blood constitutes "the prevailing point of honor among the whole nation"; and the acceptance of pecuniary compensation is, notwithstanding its recommendation by the Koran, considered vulgar. Writing of the Swedes, Geiger says—and his words apply with equal force to nearly all the early German nations—"Revenge for blood was a sacred obligation. It was at once the dearest heritage and the condition of every other, for in the olden time, if the father lay slain, the son could not inherit until he had avenged him." The old Salic laws likewise so linked the feuds of the family with its inheritances that a renunciation of the one worked an incapacity for the other. The loss of reputation which among the American Indians and other existing barbarians is universally incurred by failure to avenge blood is a matter of general notoriety. The difficulty experienced in some modern States in suppressing the duel is a faint illustration of the incorrigibility of blood-avengement; it being borne in mind that the modern code of honor is the conventionality of one class of society, while the old principle of retaliation rested on a universal passion and inflamed all classes alike, and that, while the modern duelist can forego his personal remedies, assured of the advantage of a matured system of law, the avenger was obliged to choose between his vengeance and a pecuniary composition, with the third alternative, in some instances, of a crude and inefficient judicial proceeding.

When King Alfred, outstripping the age in which he lived, and probably inspired by the example of Moses, denounced against willful murderers the punishment of death, his law was a dead-letter, and remained unexecuted during his own reign and those of several of his successors. The people preferred to redress their own grievances. Even long after pecuniary compositions for felonies had been abandoned, the laws of England continuing to provide two concurrent methods of prosecution for murder, one by indictment in the name of the king, and the other by appeal of felony at the suit of the kindred of the deceased, the latter was so confessedly the more favored remedy that, lest it might be barred by an acquittal under an indict-

ment, no indictment was tried until after the expiration of the year and a day within which an appeal of felony might be instituted. This remained the practice until third Henry VII., when, in order to avoid these delays, it was enacted that acquittal on trial of an indictment should be no bar to an appeal of felony for the same offense. In the legislation of some countries, the conflict with reference to blood-avengement between the dictates of public policy on the one hand and the prevalent passions and notions of honor on the other was productive of a laughable incongruity. The law of Gottland, while making express provision for the appearance of the wrong-doer in court under safeguard, in order that he might offer the prosecutor a price in atonement of his offense, at the same time declared the prosecutor who accepted it at the first offer, even after the expiration of a year, to be a shameless person.

The tenacity with which the avenger adhered to his right of redress and the difficulty of controlling him in the exercise of this right are further attested by the character of the expedients by which it was sought to fortify measures aiming at his restraint. Thus Moses, though the Israelites were in his day quite familiar with the public prosecution of crimes, some of which were entirely withdrawn from the domain of private retaliation, found it still necessary to recognize the blood-avenger's right personally to pursue and slay without form of law the willful murderer: "The avenger of the blood shall slay the murderer; when he meeteth him he shall slay him."

But, as under most primitive codes of honor, so among the early Israelites the principle of blood-avengement was so malignant as to require retaliation even against the involuntary man-slayer. The instrument of death, whether man or beast, the avenger was in honor equally bound to destroy, without reference to the malicious or accidental character of the homicidal act. The flagrant injustice of punishing with death involuntary acts void of moral guilt, was in the Mosaic age, probably as manifest to large numbers of the Israelites as to Moses himself; yet so deeply rooted was the practice in the traditions of the people that the great law-giver dismissed as impracticable the idea of abolishing it. His scheme for ameliorating the hardships of both the willful murderer and the involuntary homicide by the designation of cities of refuge within the limits or vicinity of which they could find protection from the avenger, the former until he should have opportunity to prove his innocence, and the latter until the occurrence of some event with which his final discharge from liability could be plausibly linked, bears witness upon its face to the difficulty he anticipated in its enforcement. That his plan might be fortified by religious reverence and sacred associations, he provided for the selection of the cities of refuge from among the cities of the Levites, and dated the freedom of the excusable homicide from the death of the high priest. It is likely that among all early races the right of sanctuary

has derived its strength from the considerations lying at the root of these Mosaic regulations. For although the absolute exclusion of violence from sacred precincts may have been originally suggested by religious sentiment, the widespread and tenacious application of the principle to criminal refugees must be mainly ascribed to the necessity so widely experienced of interposing obstacles to the avenger of blood; as is perhaps indicated by the circumstance that, as the exercise of avengement has been superseded by public prosecutions, the right of sanctuary has almost uniformly fallen into disrepute. Analogous in origin and aim to the right of sanctuary are the customs quite various and widely prevailing by which avengement has been prohibited during certain sacred seasons or occasions. Among the Swedes, for example, the Church contributed, as described by Geijer, to the abolition of blood-feuds by declaring all holidays and periods of some length at the great festivals consecrated to peace; and, ultimately, by throwing a similar protection over the sowing and harvest times. The Frisian was not to be molested by the avenger while going to or returning from church. There are some tribes of American Indians with whom all crimes except murder are buried in oblivion by the yearly sacrifice; so that the mention of them, or of any occurrence which brings them into recollection, is forbidden. If a Kenisteno chief wishes to settle any difference between his people, he announces his intention of opening his medicine-bag and smoking in his "sacred stem"; and no man who entertains a grudge against any of the party there assembled can smoke with the sacred stem.

The tenacity with which men clung to their right of personal retaliation can not be too strongly emphasized. When, by the demoralizing prevalence of feuds, society was first awakened to the necessity for taking measures to mitigate or suppress them, it is undoubtedly true that even if there had been a general willingness to abandon private revenge in favor of public prosecutions, the men of that period were incapable of either conceiving or executing so comprehensive a remedial scheme.

On the contrary, without any thought of the ultimate displacement of their revenge, they sought by various devices only to mitigate its excesses. But that displacement was made doubly difficult and the movement by which it was accomplished was in its details controlled by the stubbornness with which, even after comprehending the possibility of the new system, the people insisted upon adhering to their rights under the old. If further evidence or illustration of these truths is desired, it can be abundantly gathered from the sketch which it is now proposed to give of some of the steps by which societies, in their efforts to control the avenger and regulate avengement, were slowly and at first unconsciously led toward the cardinal doctrine of criminal jurisprudence, that it is the function of government to protect by suitable penalties its citizens in person and property from the violence and

fraud of one another. "In order that revenge might not continually generate new revenge," says the historian of the Swedes, "the law essayed its earliest exercise of authority in reconcilement." At a time when murder was a purely private wrong, of which government took no cognizance, and the right of retaliation was thought too sacred for government to deny, the public interested itself only by discouraging revenge through the agency of public opinion, and by inviting and recommending pecuniary compositions with wrong-doers at rates which were usually fixed by law or custom, without, however, assuming to coerce either party into a settlement. Under such circumstances, if the avenger accepted the sum fixed by law as the price of composition, and afterward also took his revenge, this, as Montesquieu says, referring to the law of the Lombards, contained a public as well as a private offense; was a contempt of the law itself—a crime which the legislators never failed to punish. Later, the law, in order to avert feuds, declared it a crime to refuse to offer or accept pecuniary composition for murder. Government, while it had not yet undertaken to prevent or punish ordinary murders or larcenies, had been driven to apply itself to the suppression of feuds; and the withholding or rejection of composition money tending to defeat its efficient discharge of that function had the properties of a true crime, and was promptly recognized and punished as such. That pecuniary compositions for bloodshed were everywhere first made obligatory, rather to avert feuds than to punish wrong-doers, is attested by a great variety of circumstances. For instance, in fixing the amount to be paid in composition, the chief and usually the sole question or criterion seems to have been, What sum will offer to the avenger a sufficient inducement to forego his revenge? Rotharis, in the law of the Lombards, declares that he had increased the compositions anciently accustomed for wounds, to the end that, the wounded person being satisfied, all enmities should cease. Upon the same principle is to be explained the well-known tendency of early laws to adjust their penalties with principal regard to the aggrieved person's probable degree of exasperation at the time of detecting the wrong-doer.

The law of the Allemans, which, while undertaking to enforce compositions for stale offenses, conceded to injured parties the privilege of righting themselves on the spot and in the first transport of passion, finds a counterpart in the curious and yet under the circumstances perfectly natural distinction made in the Twelve Tables between manifest and non-manifest theft. Persons detected in the act of stealing, or with the booty in their possession, were liable to the punishment of death if slaves, and, if freemen, became thereby the bondmen of the owner of the property; while, if detected under other circumstances, they were only obligated to refund double the value of the stolen property. The marked incongruity, from a modern standpoint, of these two punishments was supposed by Montesquieu to have

originated in Lacedæmonian theories of theft, and to have been handed down from ages when the crime of stealing was a small matter compared with the blunder of being found out. In other words, that the real crime consisted in being detected, and that hence, the longer detection was postponed and the more effectually the booty was disposed of or concealed, the lighter was the penalty imposed. Whatever may be said of the accuracy of this explanation, its ingenuity can not be denied.

On the other hand, Sir Henry Maine traces the widely discrepant penalties under consideration to a tendency, on the part of early administrators of justice, to "simulate" the probable acts of persons engaged in a private quarrel. "It is curious to observe," he says, "how completely the men of primitive times were persuaded that the impulses of the injured person were the proper measure of the vengeance he was entitled to exact, and how literally they imitated the probable rise and fall of his passions in fixing the scale of punishment."

Viewing these provisions of the Roman code in connection with other primitive laws, there can be no doubt that their scale of penalties was graduated, not with reference to the vengeance the injured party should be "entitled to exact," but with reference to the least amount of punishment by which, under given circumstances, he could probably be appeased. Pecuniary compositions for bloodshed, prevailing, as they presumably have, at some period in the history of every race, can not indeed be accounted for on any theory of punishment. They were conceived and established for purposes of pacification, apart from considerations of punishment or discipline. Blood for blood is an instinct of human nature; it is the justice which among every race was meted out with unsparing hand by the kindred of the slain when the burden and privilege of redress were upon them, and again by the state when she assumed the punishment of crimes. Pecuniary compositions prevailed only in the enforced absence of truly primitive remedies during that transition period when government was too wise to countenance the avenger, and not wise enough, or too feeble, to administer penal justice. It must be admitted that compulsory compositions, after they had superseded the practice of retaliation, came ultimately to be maintained with a view largely to the punishment and prevention of wrong-doing, and by a kind of inertia were carried over into periods capable of sustaining a true criminal law and already in the partial enjoyment of it. Even then, however, they proceeded upon our theory of damages against tort feasors. They were never at any time entitled to a place in the law of crimes. Returning from our digression, it is to be remarked that the adoption by the state of regulations for the control of parties at feud necessitated public prosecutions and punishments in order to insure their observance. One of the earliest methods of mitigating feuds was to

allow the relatives of the wrong-doer to withdraw themselves from his feud on condition that they should entirely abandon him. If, after taking advantage of this law, they gave the wrong-doer assistance, they not only forfeited the protection which the law guaranteed them, and so were involved in the feud, but they so obviously sinned against the dignity of the state and its law that they were finable to the king. Such was the law of King Edmund of England. So, if, after the law had guaranteed the relatives of the culprit immunity from the feud in consideration of their abandonment of him, the injured party still took revenge on them, all his property was forfeited, and he was declared to be an enemy to the king and all his friends. In like manner, government in some instances undertook to give legal force to customs, many of which occur among our Indian tribes, which sought to discourage feuds by limiting the time within which revenge could be taken, or to restrictions upon the mode or measure of redress suggested by considerations of humanity. Although Mohammed, in the Koran, adheres to the law of personal retaliation for bloodshed, he counsels forgiveness or composition on the part of the aggrieved persons. But, against the person who, after receiving composition money as contemplated by his law, still proceeds to take his revenge, he denounces a "grievous punishment." The process of enforcing these and other limitations upon parties at feud resulted in developing and illustrating the idea of regulating by criminal laws the conduct of citizens toward one another, and thereby paved the way for the subsequent more general application of the same principle. There was another class of measures which tended to the same end by serving especially to mature a judicial machinery, and to familiarize the people with its operation. Next to its total abolition, the most effective remedy for the evils of blood-avengement was to forbid its exercise until the accused person should have had an opportunity to submit the question of his guilt to investigation in court. Under such circumstances a court was not a bar of justice at which accused persons were arraigned, but a place of refuge to which they fled. The Israelites had under the Mosaic laws in one respect passed this stage of development, since the public had undertaken to execute judgment against offenders when the avenger so desired. Yet an accused person only became entitled to a hearing in court after reaching a city of refuge, up to which time the avenger was at liberty to take his own redress without legal intervention. Having arrived at the city of refuge, the fugitive was entitled to have the question of his guilt investigated. If found guilty, he was either delivered into the hands of the avenger, or at the option of the latter was publicly executed, the prosecuting witnesses casting the first stones. That among the Germans, also, the first entertainment by courts of criminal charges was in the interest of the accused, is, as already remarked, settled beyond controversy by Montesquieu. Additional and curious illustra-

tion of the fact is afforded by the Swedish law, which not only threw the protection of the court around the accused while he negotiated with the adverse party for composition, but in case of the rejection of his reasonable overtures restored him to liberty with the right to carry full arms, and to defend himself against his enemies as well as he could. The custom very widely prevailing, by which a party found guilty of crime is delivered by the court to the prosecutor, to be executed or otherwise disposed of at his pleasure, is obviously an outgrowth and incident of the original protective function of courts, and wherever found is indicative of the former prevalence of that kind of judicial interference. This may be said to be the universal method of execution among such of the barbarous tribes as have attained to any judicial investigations at all. The same is generally true of Mohammedan countries.

Even in England, until as late as Henry IV., it was the custom in appeals of felony for the appellor and his kindred to drag the convicted appellee to the place of execution.

For the time employed in the trial, and the protection afforded by it, a reasonable compensation, called *Fredum* by the Germans, was usually paid by the accused to the judge or king. Under the Koran this debt of gratitude took a peculiar form. In order to compound for murder it was necessary not only to satisfy the family of the deceased, but also to ransom a brother Moslem from captivity. It is not difficult to understand how impositions of this sort, exacted at first for time consumed and protection afforded by the state for the accused, might readily adapt themselves to and even assist in the development of criminal law, by gradually assuming the character of fines for the offenses charged. Another line of progress of importance in some societies consisted in a gradual enlargement of the classes of offenses in which the king or state was supposed to have such an immediate interest as to justify a claim to a part of the composition money. Thus an injury to the person or property of any of the king's household, retainers, officers, or agents, was early construed to be an injury to himself. So, likewise, with wrongs committed against the guests of the king or persons of a household by whom he was entertained; or violence committed in the immediate presence of the king or in his castle, and afterward in the city or province where he was residing; or under other circumstances which, within the slowly expanding ideas on the subject, could be construed as involving an offense against the king's peace or dignity. It is an observation of M. Say that, in every branch of knowledge, example has preceded precept. So it was in the early history of criminal law. To a very great extent it was practiced before its theory was conceived or its first principle formulated. It was only after its judicial machinery had been developed by such random or diverse considerations, and for such special purposes as those heretofore enumerated, and after the people were thereby famil-

iarized with its employment in favor of or against many classes of wrong-doers, that the practicability and propriety of its application to offenders generally were first perceived.

SAPORTA'S WORLD OF PLANTS BEFORE THE APPEARANCE OF MAN.*

TRANSLATED FROM THE FRENCH BY MISS E. A. YOUMANS.

MEN of science, whose patient researches have accumulated the proofs of the theory of evolution, have perhaps found more facts in support of this great philosophical doctrine in the vegetable than in the animal world. When we say the vegetable world, we of course mean chiefly fossil vegetables. It is only by the study of extinct forms, and their comparison with the living flora, that the affinities between actual types and distant ancestors have been discovered, and their mode of evolution revealed. Vegetable paleontology, it is true, is yet in its infancy, and has many great gaps; still, the rapidity with which it is being developed, and the prodigious number of facts that have been already collected, give good ground for the hope that the day is not far distant when we shall have surely determined the ancestral lines of most of our plants. To this the efforts of paleontologists are tending, and their activity is beyond all praise. During the last twenty years their discoveries have furnished the matter for large volumes and for many memoirs, published in the reports of academies of science, in the bulletins of geological societies, etc. But the profound lessons derived from these discoveries have hitherto been almost the exclusive possession of scientific men. People of general intelligence, who are interested in all progress have known little of the results obtained. This injustice could be no longer tolerated. A complete treatise was required, written in a style that all could comprehend, and summing up the progress thus far accomplished; and M. de Saporta, one of the most eminent authorities in vegetable paleontology, has just published such a work.

He devotes his first chapter to the theory of evolution, passing successively in review the most important arguments in its favor. Notwithstanding the great interest of this subject, it will not detain us now, for we wish to examine the main body of the work. Besides, Saporta is now writing for the "International Scientific Series" a book devoted to the study of evolution in the vegetable kingdom, where he will show the line of descent of the great families of plants.

* The World of Plants before the Appearance of Man. By Count de Saporta, Correspondent of the Institute. 8vo. 416 pages, with Thirteen Plates, of which five are colored, and One Hundred and Eighteen Figures in the Text. Paris: G. Masson. 1879.

The study of fossil flora not only enables us to follow the evolution of plants from their remotest known ancestors to their present actual descendants, but it throws much light upon the past mysteries of the earth, and especially upon the climatic conditions which controlled its surface while the slow revolutions of organic life were going on. We know what numerous causes concur to form a climate; latitude and longitude, the direction of winds and of currents of water, the nature and relief of the soil, and the distance from the sea. All these causes have their respective known effects, and have acted in the past as they act now; yet we know that, if it were needful to determine the amount of influence due to each of these agencies in the different geological epochs, we could not do it; the difficulties are too great. But in one case, that of latitude, we can find out its ancient effects by analogy with what is passing under our eyes, and by abstracting all other influences. We know that the obliquity of the sun's rays increases with latitude, and that temperature diminishes in the same proportion; that the higher the latitude of a region the less heat has its climate. But we know also that vegetation marches with temperature, provided always that soil and moisture are favorable. The floras of the temperate and polar regions show clearly the decrease of temperature from the equator to the pole. There exists between a flora and the climate in which it lives a relation so close that, knowing the one, we can represent the other. Palms do not grow in Greenland nor fir-trees on the plains of equatorial Africa. Each climate has its flora, and each flora its climate.

Paleontology has established the permanence and universality of this law; but it has at the same time established a singular fact which remains inexplicable. It is this: the different climates of the earth have not always been what they are now, either as to temperature or distribution. We speak only of those epochs which have succeeded each other since the time of the most ancient known plants. If we transport ourselves in thought to a time toward the end of the Tertiary period, and then, leaving behind us the Quaternary epoch, follow the course of the ages, we find, as an increasing enlargement of the tropical zone, that which is equivalent to an increase of temperature for the whole earth. More extended in the Pliocene epoch than in our day, this zone was still greater in the Miocene epoch, and yet greater in the Eocene, and so on till we reach a time when it embraced the whole surface of the earth, bestowing everywhere an equal temperature, feebly oscillating between certain limits. This climatic equality, which, according to Saporta, reaches at least as far back as the time of the coal, would probably cease at the epoch of the inferior chalk. Such is the fact established by examination of the flora of different ages.

Let us proceed to details. The Quaternary epoch, contrary to the opinion of the majority of geologists, was not, in France, and probably also in other countries, a period of universal cold. The term

glacial which has been applied to it is certainly appropriate, because of the enormous and unknown extension of the glaciers, the traces of which are the principal character of the epoch. But at certain distances from existing glaciers there doubtless existed valleys with a

FIG. 1.—IDEAL VIEW OF THE BANKS OF LAKE AIX AT THE TIME OF THE FORMATION OF THE GYPSUM.

warm or at least a temperate climate. The mixed fauna and flora of this period abundantly prove this. The remains of hug animals gathered in the ancient alluvium of the Seine and Somme, as determined by MM. Larted and Gaudry, demonstrate that many species

indicating a very cold climate are found associated with those of a diametrically opposite character. Besides the mammoth, we encounter the ancient elephant, approaching that of India; the hippopotamus of African rivers peopled the waters of the Seine; while the hyena of the Cape frequented the meridian of France. The study of the forest flora, of which we find numerous remains in the contemporaneous tufa, leads to the same results; the vine, the laurel, the ivy, are found in abundance, not only in our southern regions, but also at Moret, near Paris. We find there also the much tenderer laurel of the Canaries. The northern trees of the same epoch were pines, lindens, maples, and oaks.

All these facts prove that the quaternary animals and plants characteristic of a cold climate existed only in the neighborhood of glaciers; and that, close by, in the valleys, lived creatures whose presence indicated a climate softer and more humid than ours. The mean annual heat necessary to their existence would be, at least, 14° or 15° centigrade. But, if we place ourselves now in the full Pliocene period, say near Lyons, we encounter the same vegetables, with others of a more southern character. At this epoch, in fact, the laurel-rose flourished on the banks of the Saône in company with the laurel, the *avocatier* of the Canaries, the bamboo, the magnolia, and the evergreen oak. The well-known climatic needs of these species warrant us in assigning to the country a mean annual temperature of 17° or 18° centigrade, and, as the actual mean temperature of Lyons is only 11°, we can judge of the difference of temperature which separates our epoch from that of the Pliocene. Moreover, as Saporta remarks, the figures which express the climate of Lyons during the Pliocene epoch are not only higher than those which apply to the neighborhood of Marseilles in Quaternary time, but, in place of corresponding to the 43° of latitude, these higher figures coincide with the 46°. They mark a progression of heat corresponding with latitude, the effect of which is to raise the temperature of northern regions in proportion as we bury ourselves in the past.

These curious phenomena appear still more evident and more general, if we transport ourselves in thought to the Miocene epoch. The entire unbroken documents abound in the boreal hemisphere, and we can there exactly determine the climates of all latitudes from 40° to 80°. Admirably preserved fossil plants, brought from the polar regions by different travelers, show that glaciers have not always desolated the pole. One of the principal deposits of these vegetables was found on the western side of Greenland at Atanekerdluk in 70° of latitude in the adjacent island of Noursoak. On the steep sides of a ravine one thousand feet deep, there exist entire beds of petrified leaves and other *débris* imbedded in a very ferruginous rock. The vast accumulation of leaves is truly surprising—trunks yet in place; flowers, fruit, insects accompanying them. M. Heer, who has studied

these precious remains, says that here arose a vast forest where abounded sequoias, poplars, oaks, magnolias, ebony, holly, walnut, and a host of other species. Still farther north, at 80° of latitude, were found aquatic

Fig. 2.—Principal Palms and Cycadeæ of the Middle Tertiary in Europe.

plants, pond-weed, water-lilies, rushes, etc., and terrestrial plants—bald cypress, thyme, fir, plane, linden, maple, mountain-ash, and even magnolias, forming a grand forest. The illustrious Professor of Zurich, M. Heer, regards many of these plants as miocene, and concludes that

if these latitudes at this time were disposed as they are now—that is, if the earth's axis has not been displaced—all the earth received more heat, and the line of the tropics must have risen toward the north. The difference of the Miocene period may be valued at 25° or 30° of latitude—that is, we must at present descend 40° or 45° to find the temperature which then existed in Greenland.

The study of the more ancient floras brings new proof of this phenomenon of the extension of heat into the higher latitudes, and conducts us finally to that equality of climate of which we have spoken. "We are forced to conclude, however," remarks Saporta, "that when we reach the time of the coal and the most remote period in the history of organic beings, if there has been no change in the relations of the heat that falls upon our globe, there have doubtless been other changes profound enough to impress upon it a very different aspect from that which it has since presented, and to create conditions of existence about which we can form no idea." We are, in fact, ignorant of the conditions in which living beings first made their appearance and were developed. There have been many hypotheses about it, but the facts on which they rest are yet neither sufficiently numerous nor convincing. For the settlement of this question we must await the future.

As to the cause of climatic equality over all the earth in the Primary and Secondary epochs, we are equally in the dark. All the explanations that have been given have been successively rejected. The displacement of the axis of the earth, the inclination of that axis on the orbit of our planet, the precession of the equinoxes, etc., are some of the hypotheses put forth on this subject. We can not here enumerate them all; but there is one on which Saporta insists, not because it explains everything, but because it agrees more or less with the celebrated cosmogony of Laplace, and accords with the phenomena of the primitive world as revealed by science. This hypothesis was put forth some years ago by M. Blaudet. We know that, according to the theory of Laplace, the entire solar system was originally an immense nebula which has since condensed little by little, and successively given off rings of cosmical matter which have become planets. The central star is hence more and more reduced, has become more dense, more luminous and more ardent, until it has attained the dimensions and properties of our actual sun. In other words, if we could trace backward the course of the ages, we should find the sun progressively augmenting in volume, but its heat and light would diminish in intensity in the same proportion. We do not know what sun lighted the earth when life first appeared upon it, but, from the theory of Laplace, we may suppose that it was much larger than ours.

Such conditions, however, would explain many phenomena. This great sun, occupying a good part of the horizon, would give a twilight so luminous and so prolonged as perhaps to annul the night. Sending

his perpendicular rays much farther from the equator than now, the torrid zone would be thus enlarged. The calmer light, the more gentle and equalized heat, the thicker and more humid atmosphere, explain that equalization of temperature, those days half veiled and transparent nights, and that tepid climate of the polar regions, that we might consider as presiding at the development of primitive life. Finally, the primitive sun, by its slow condensation, passing insensibly into its present state, necessarily forced the retreat of the torrid zone, thus ending the anterior equality of the climate, permitting cold to become established at the pole, and concentrating heat at the equator. Such is the bold but attractive hypothesis of M. Blaudet. No doubt it leaves many points obscure, but the numerous partisans of the theory of Laplace will not hesitate to acknowledge its importance, for, in reality, it is part of the theory itself.

It remains now to review the remarkable chapter that Saporta has given to the study of vegetable periods. We may remark at the outset that this word "period" implies no such general convulsions as the first geologists believed in, who supposed the history of the globe broken into sharp periods, each of which was inaugurated by a distinct creation and terminated by a sudden and universal destruction. Saporta takes care to warn us against this error. "Nature, always active," says he, "has had no intermittence nor time of sleep. Life, since its first appearance, has not ceased to inhabit the earth. Depressed sometimes, interrupted never, there has circulated without respite a constantly fertile sap. The epochs and revolutions which geologists have named are valuable only as serving to introduce great dividing lines in the bosom of an incalculable duration, but a closer view reveals these beings always succeeding each other; the extinction of some among them would not prevent survivors from occupying their place. Physical revolutions, essentially accidental and unequal, have never been radically destructive. If some periods have been less favorable than others to the development of life, these relatively impoverished intervals have possessed organized beings that, afterward multiplying and diversifying, have easily repeopled the globe."

Saporta divides the world of fossil vegetables into four great periods: 1. The Primordial or *eophytic*, corresponding to the Laurentian, Cambrian, and Silurian; 2. The Carboniferous or *paleophytic*, comprehending the Devonian, Carboniferous, and Permian; 3. The Secondary period or *mesophytic*, commencing with the Trias and reaching to the end of the chloritic chalk; 4. Finally, the Tertiary or *neophytic*, embracing all the formations from the chalk of Rouen up to and including the Pliocene.

The flora of the eophytic period is unknown. The *débris* which represents it has in general a character so vague that there is yet no agreement upon its true nature. The graphite found in the Laurentian indicates, however, that from this epoch vegetables existed in great

abundance. In the Cambrian and Silurian, fossils are found that are differently interpreted, and in which at present some think they see algæ. The famous bilobites, so abundant at the base of the Silurian, appear also to have been algæ of very great height. Finally, certain marine plants, as those that are represented by Fig. 3, are connected with a type of algæ so marked that it is difficult to mistake them.

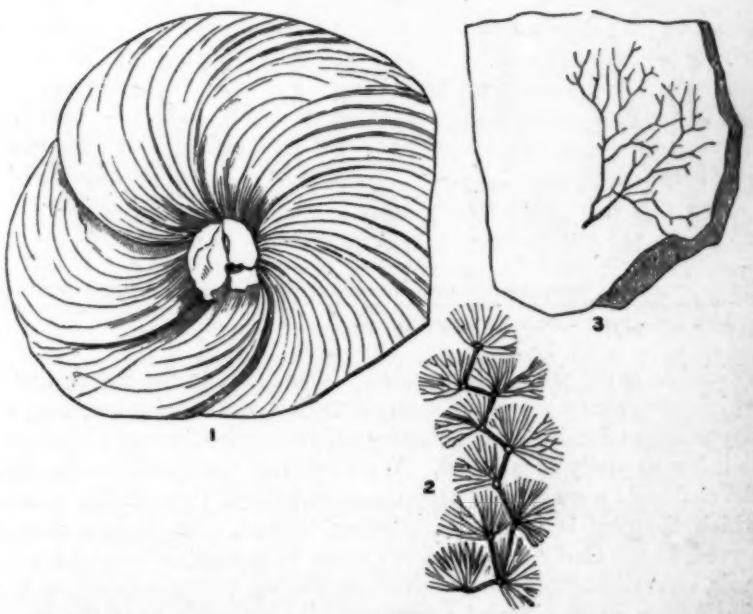

FIG. 3.—PRIMORDIAL MARINE PLANTS: 1. *Spyrophyton* of Hall (Silurian of America). 2. *Murchisonites Forbesi* (Goepp) (Silurian of Ireland). 3. *Chondrites fruticulosus* (Goepp).

Many of these plants are undeniably linked with more modern types, of which they bear the generic form, and prove that this primordial flora is not really separated from that which followed it. We can even affirm that certain Silurian algæ have had a duration so prodigious and a tenacity of character so pronounced that their last direct descendants were living in the European seas in the middle of Tertiary time. As to primordial land-plants they are excessively rare, and those that we have gathered seem to demonstrate that in the Silurian epoch to which they belong the vegetable forms represented types that we encounter in subsequent formations, and that are characteristic. In Fig. 4 are shown those that M. Lesquereux observed in the Upper Silurian of the United States. Among them are the *Psilophyton*, which disappeared with the Devonian, and the ambiguous characters of which approached at the same time the ferns by the Hymenophyles, the Lycopodiaceæ by Psilotum, and the Rhizocarpes by Pilularia.

With the Devonian things changed. The bad state of preservation of fossil vegetables belonging to this formation has not permitted us to study them perfectly; but, from the aspect of those which we possess, we conclude that at this epoch the vegetable kingdom was already vigorous and varied, and that nature while in its infancy put forth the carboniferous flora, the almost inconceivable exuberance of

FIG. 4.—PRIMORDIAL TERRESTRIAL PLANTS OBSERVED BY M. LESQUEREUX IN THE UPPER SILURIAN OF AMERICA: 1. *Pellophyton cornutum* (Lesquereux). 2-4. *Sphenophyllum primoeis*. 5. *Annularia Romingeri*. 6. *Protostigma sigillarioides*.

which has never since been equaled. This flora, to the description of which numerous works have been devoted, is still more interesting and important as furnishing the elements of the coal—the soul of industry, as it has so justly been called. We know that the conditions in which the coal-beds were formed very much resembled those in the midst of which the peat is now actually being formed. As Saporta has observed, in the Carboniferous epoch there were emersions upon a grand scale, emersions succeeding each other, flowing over and receding from the insular or continental space, until its recovery from the waters. This action of the waters would produce a low bank or shore around the primitive land, the relief of which would tend to become more accented, and at length would retain the waters coming from the interior and unite them at the bottom of extensive depressions. In this way were formed vast lakes, with vague banks and shallow waters, easily invaded by plants loving an aquatic station. If we join to this the humid warmth, the thickness of the atmosphere, charged with vapors, causing frequent and violent rains, we perceive how favorable were the conditions for the development of the carboniferous vegetation.

The plants of this flora belong exclusively to the two classes of vascular cryptogams and gymnospermous phanerogams. At the head of the cryptogams were the Calamarias, which recall on a gigantic scale the Equisetaceæ of our day; by their side Asteraceæ, Annularia, Sphenophyles; then come ferns of very varied form and structure, and Licopodiaceæ of the type Lepidendroideæ. Certain plants, the Bornia, Calamodendreæ, and Sigillaria, form connecting links between cryptogams and phanerogams. These were gymnosperms, that is, plants assimilable by the class *Cycadeæ* to the conifers and the ac-

tual Gnetaceæ. The true phanerogams, the angiosperms, appeared much later. Further, the carboniferous flora comprehended some Cycadeæ, such as the *Noeggerathia foliosa*, and a pterophyllum discovered recently by M. Grand' Eury; some true conifers, as the Walchia; some Taxineæ more or less like our Ginkgo; and, finally, a great number of Cordaïticæ, most of which were great trees so perfectly preserved that they could not only be placed at the head of the gymnosperms, but their affinities with the class of angiosperms could also be observed.

The Permian flora, which succeeded the Carboniferous, is only a pale reflection of it. The characteristic type of the preceding age has disappeared, while the others, the Cycadeæ, the conifers (Fig. 5), and the Taxineæ, tend to preponderate. The Permian is an epoch of transition, having ambiguous characters. The constituent elements of the coming vegetation were being developed. Saporta says of the Trias, which commences the Secondary or mesophytic period, that "it appears to correspond to one of those periods of revival where the

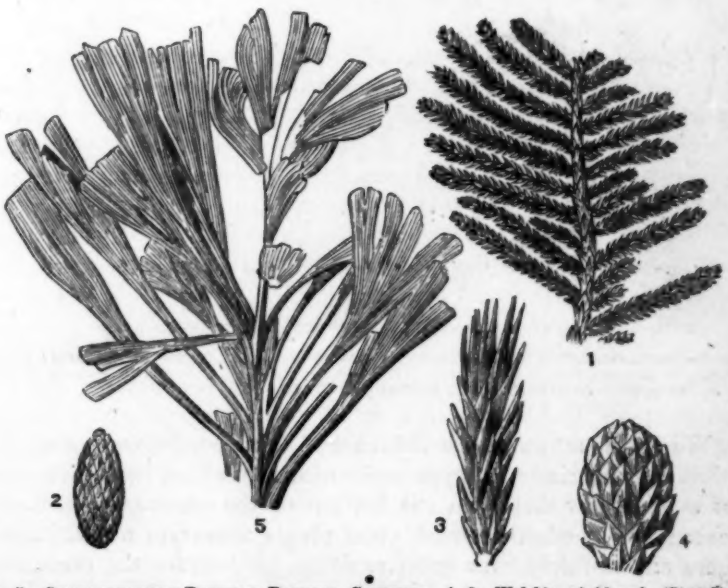

FIG. 5.—CHARACTERISTIC PERMIAN PLANTS: CONIFERS. 1, 2. *Walchia piniformis* (Strouh)—1, branch; 2, detached cone. 3, 4. *Ulmannia frumentaria* (Goepp)—3, branch; 4, strobile. 5. *Ginkgophyllum Grassetti*—Sap, branch, leaves (Permian Schist of Lodove and Herault).

failing types finally disappear, while those which displace them are successively introduced. The first leave chasms because they are reduced to a decreasing number of individuals; the last are yet obscure and rare. Both old and young are equally feeble, and, when these two extremes meet, the apparel of nature seems poor and monotonous."

At the beginning of the Jurassic period a transformation is already

manifest, and we soon find ourselves in the presence of a new flora, where the carboniferous types have disappeared, but where, except some rare monocotyledons, the angiosperms are still wanting. Always cryptogams and gymnosperms, the first represented by ferns and Equesitaceæ, the second by Cycadeæ and conifers. From Spitzbergen to Hindostan, from Europe to Siberia, everywhere the same vegetable forms, so that the character of the Jurassic flora is monotonous, lifeless, and relatively indigent. However, we quickly perceive two sorts of vegetation: one peculiar to low and humid plains, including beautiful ferns and Cycadeæ (Fig. 6); and the other covering the hilly regions, and composed of different genera of the same families, but chiefly of tall conifers, which in great part composed the forests of that time.

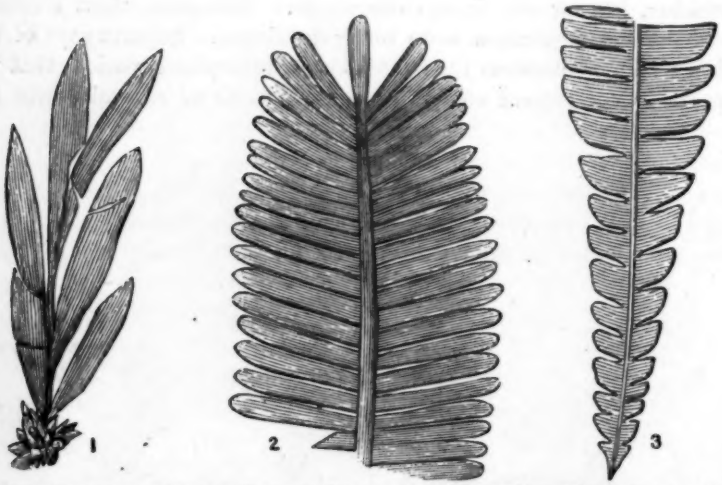

FIG. 6.—CHARACTERISTIC JURASSIC PLANTS; TYPES OF CYCADEÆ OF HUMID LOCALITIES: 1. *Podozamites distans* (Presl.); young plant. 2. *Pterophyllum Jaegeri* (Brongn.); summit of a leaf. 3. *Pterozamites comptus* (Schim.); interior part of a leaf.

We know not under the influence of what conditions organic evolution, and especially the appearance of dicotyledons, has taken place; but we do know that from the horizon of the cenomanne chalk commenced the neophytic period, these plants appear in a multitude of places and multiply with great rapidity. Wherever the cenomanien is found we find the remains of that age, proving the predominance of dicotyledons and the decrease of Cycadeæ and conifers. "This revolution," says Saporta, "has been as rapid in its progress as universal in its effects." It would certainly be interesting to follow the author in his enumeration of the ancestors of our common plants, and his description of the progenitors of the poplar, the beech, the ivy, the chestnut, the plane-tree and others, but it would extend this article beyond the limits of our space. Besides, we have followed vegetable evolution through its principal phases—that is to say, we have in some

sort witnessed the successive appearance of different classes of plants, we have seen the rising and falling movements of vegetation, periods of activity alternating with periods of relative repose, and that succession, or better, that procession of phenomena which has enabled us, if not to comprehend, at least to prove the transformations of life that all together are called evolution.

We shall find analogous phenomena in the series of Tertiary time, to which Saporta has given his longest chapter. This part of his work contains many descriptions of plants. They show us more than the simple succession of flora. The growing differentiation of the divers types and the consequent multiplication of species conduct us insensibly to the actual vegetable world. We see the growth of local flora, some of which are so clearly defined that we are able, by the aid of the imagination and of some well-preserved fragments, to reconstruct the principal genera and species of which they were composed. Fig. 1 represents a group of these plants so restored. The numerous modifications undergone by the vegetable kingdom during the Tertiary age, the formation of local floras, etc., are easily explained if we recall what was before said, of the influence of the medium upon living beings, and especially upon plants, that can not escape. Climatic equality no longer exists. The European Continent, up to this time made up of islands, tends now to aggregate and take on its present form ; the soil

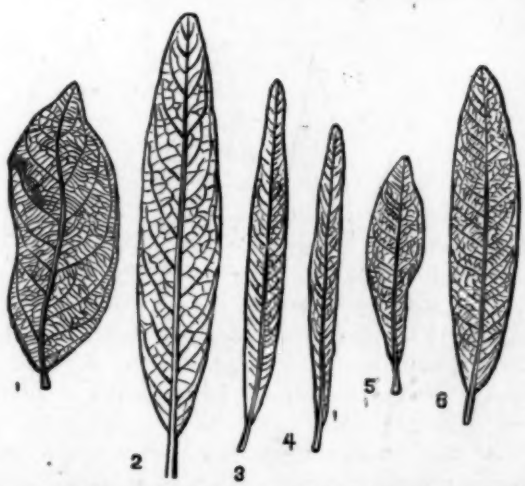

FIG. 7.—HOMOLOGOUS FORMS OF PALEOCENE AND EOCENE OAKS COMPARED (Types of entire leaves): 1. *Quercus Lamberti* (Wat.) (Paleocene). 2. *Quercus taeniata* (Sap.) (Middle Eocene). 3. *Quercus macilenta* (Sap.) (Middle Eocene). 4. *Quercus paleophellos* (Sap.) (Upper Eocene). 5. *Quercus elliptica* (Upper Eocene). 6. *Quercus salicina* (Upper Eocene).

is subject to movements of oscillation, which often change the configuration and relief of various countries. Lakes of fresh water are formed, and then disappear. The nature of the soil varies as marine deposits recapture it from deposits of fresh water ; and reciprocally.

This instability of the environment has produced an instability of the flora, and caused those differences which have resulted in the European vegetation of our time.

As before remarked, in speaking of ancient climates, when we go back in time, and particularly Tertiary time, we see the vegetation taking more and more of a tropical character. Hence in these epochs there existed in Europe a multitude of forms which can not live there now. Palms and Cycadeæ (Fig. 2) and large, beautiful ferns were long ago exiled. Other forms, as the laurel, the vine, the ivy, have never quitted the region where they were born, or, at least, where they appeared for the first time.

The number of figures that Saporta has interspersed with his text, representing the principal vegetable types of the past, offer us the still further advantage of comparing species of the same type, and verifying by inspection the respective modifications of these species, and their passage from one to the other. Without doubt, we are far from possessing all the terms of all the series; but what we know of some enables us to judge by analogy that what has happened with one genus may happen with others. See, for example, the forms of Pliocene and Eocene oak (Fig. 7), which show clearly how climate has affected this species from the formation of Gelinden at the base of the Pliocene to the gypsum of Aix, that is, the superior Eocene. The forms repre-

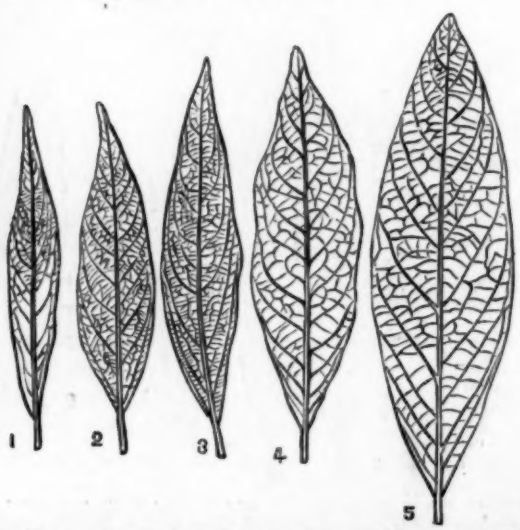

FIG. 8.—SUCCESSIVE FORMS OF THE LAUREL TYPE, SHOWING THE PASSAGE FROM *Laurus primigenia* TO *L. Canariensis*: 1-3. *Laurus primigenia*. 4. *L. princeps*. 5. *L. Canariensis*.

sented here belong to the group of oaks with entire leaves; but there is another group with leaves toothed or lobed, in which we discover analogous modifications. We see that leaves at first oval tend to become more and more slender, and these lanceolate forms express very

truly the action of the warm, dry climate of the Eocene, which succeeded the warm but humid climate of the Pliocene.

Other striking examples of these affinities of species are furnished by the laurel type (Fig. 8) and that of the ivy (Fig. 9). The large

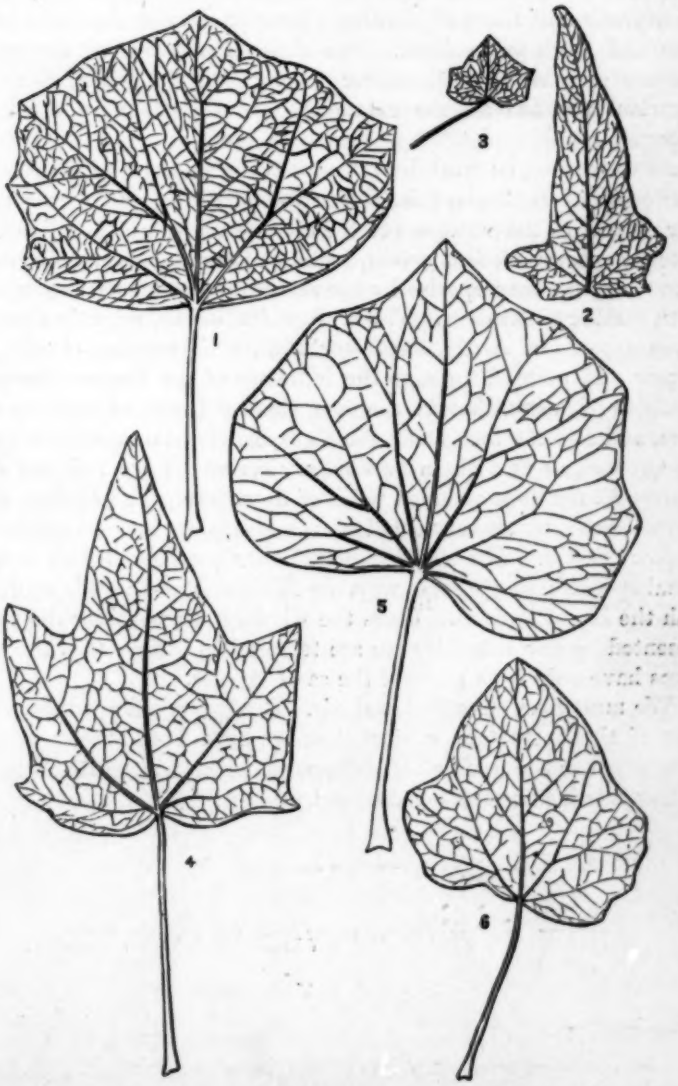

FIG. 9.—SUCCESSIVE MODIFICATIONS OF THE TYPE *Hedera* IN THE COURSE OF THE TERTIARY EPOCH: 1. *Hedera prisca.* 2. *H. Philbertii.* 3. *H. Kargii.* 4. *H. Acutelobata.* 5. *H. MacCurii.* 6. *H. Strozzi.*

varieties of *Laurus primigenia* pass insensibly into *Laurus Canariensis.* "It seems," says M. de Saporta, "that the narrow forms of this

same *Laurus primigenia*, which at the same time are the most ancient, mark the existence of a race due to the Eocene climate. This influence is gradually lessened, as seen in the expansion of the leaf as we advance toward the Aquitanian, and in the Armissan at first, and Manosque afterward. The relation between the amplified leaves of the *Laurus primigenia* and those of *Laurus Canariensis* and *Laurus nobilis* is more and more pronounced. The *Laurus princeps* of the superior Miocene approaches still nearer to our laurel; while, finally, the Canarian race has all the characters of Meximieux in the inferior Pliocene.

As to the ivy, its most distant ancestor is a species of the cenomanienne chalk of Bohemia, the *Hedera primordialis*, whose large leaves bear witness to the moistness of the climate under which it lived. The Pliocene species, *Hedera prisca*, found at Sezanne, is sensibly removed from the preceding species by the salient angles of its leaves and its much smaller dimensions. The *Hedera Philibertii*, recently discovered in the gypsum of Aix by Professor Philiberti, testifies clearly, by its narrow and pointed form, to the influence of the Eocene climate. It recalls to our astonishment the most slender forms of the ivy of Algiers, and also the forms that the European ivy takes when it runs on the ground, so that these two races may well have had the *Hedera Philibertii* for their common point of departure. The *Hedera Kargii*, characterized by its very small leaves, seems to be derived from the *Hedera prisca*. The *Hedera acutelobata* scarcely differs from the actual species; in the same way the *Hedera Mac-Cluri* is confounded with the ivy of Ireland. Upon the whole, if we consider the varieties presented by our actual ivy we are tempted to believe that the ancient forms have only been races of the same species.

We must here close this analysis. Readers wishing a better knowledge of this important subject than we have been able to give must be referred to the work of M. de Saporta, which will be found as agreeable as it is instructive.—*Revue Scientifique.*

HOW TYPHOID FEVER IS CONVEYED.

By Dr. T. J. MACLAGAN.

TYPHOID fever is one of the most common of the serious ailments of civilized life. No household is safe against it; there is no family which it may not invade. In Great Britain alone not much short of 200,000 people suffer from it every year. Of these nearly 20,000 die, most of them in the prime of life. It is even more prevalent on the Continent.

The question of the contagiousness of such a disease is one of vital

importance; and yet it is one on which the most antagonistic opinions are held.

Among the many ailments which may be transmitted from the sick to the healthy, the ones with which we are most familiar in this country are those which are grouped together under the name of "the eruptive fevers." To this group typhoid fever belongs. It includes also small-pox, typhus fever, scarlet fever, and measles. Each consists of an attack of fever of more or less definite duration, and of a local inflammation or eruption: during the course of each its poison is largely reproduced in the system; and each may be transmitted from the sick to the healthy.

There are several ways in which a disease may be transmitted:

1. Its poison may be introduced directly by inoculation, as is daily done in the case of vaccination.

2. It may pass directly into the surrounding atmosphere from the persons of the sick, and be inhaled by those in their neighborhood, as constantly happens in small-pox, typhus fever, measles, and scarlet fever.

3. It may be conveyed indirectly, and to a distance, in articles of clothing, bed-linen, etc., and, passing from them, may be inhaled by those who wear or handle them, as often happens in the same diseases. Or it may be conveyed in food or water, and enter the system through the digestive organs, as frequently happens with the poison of typhoid fever.

When we wish to say that a disease is transmitted from person to person, without defining the mode of transmission, we say that it is COMMUNICABLE. The term is a general one, which includes every mode of transmission.

When we wish to say that a disease may be transmitted by inoculation, we say that it is INOCULABLE.

When we wish to say that the poison may be conveyed in articles of clothing, in linen, in food, in water, etc., we say that these articles have been infected by the poison, and that the disease is INFECTIOUS.

When we wish to say that a disease is produced by personal contact with one suffering from it, and that the danger of catching it increases with the closeness and intimacy of such contact, we call it CONTAGIOUS.

A contagious disease, therefore, is one in which the danger of contracting it increases as we approach, and diminishes as we recede from, a person suffering from it. It is *contactuous*.

Contagion may be defined as direct infection; and infection as indirect contagion. In both a poison passes from the sick to the healthy. It is the difference in the mode of conveyance of the poison that makes the difference between the two. The distinction is one of the utmost practical importance, and must be borne in mind in discussing the question of the contagiousness of any disease. An ailment may be

infectious without being contagious. When, with reference to a case of typhoid fever in his own house, a man asks the question, "Is it contagious?" he does not wish to know whether or not some one in the next street may take the disease, but whether or not there is a likelihood of its spreading among the members of his own household, and whether or not there is danger in going near the sufferer. The only accurate and proper meaning of the word is that attached to it in the definition which I have given. That, therefore, is the sense in which it is used in this paper.

What is the nature of the poisons which pass from the sick to the healthy? Their most distinctive peculiarity is, that they are largely reproduced in the system during the course of the maladies to which they give rise. The minutest possible portion of small-pox matter, for instance, may be introduced into the system of a person who has not had that disease, and who has not been vaccinated, with the certainty of giving rise to a malady during whose course there will be formed many thousand times as much of the poison as sufficed to set the disease agoing.

Contagion, then, consists physically of minute solid particles. The process of contagion is the passage of these from the bodies of the sick into the surrounding atmosphere, and in the inhalation of one or more of them by those in the immediate neighborhood. If contagion were a gaseous or vapory emanation, it would be equally diffused through the sick-room, and all who entered it would, if susceptible, suffer alike and inevitably. But such is not the case; for many people are exposed for weeks and months without suffering. Of two persons situated in exactly the same circumstances, and exposed in exactly the same degree to a given contagion, one may suffer and the other escape. The explanation of this is, that the little particles of contagion are irregularly scattered about in the atmosphere, so that the inhalation of one or more of them is purely a matter of chance, such chance bearing a direct relation to the number of particles which exist in a given cubic space. Suppose that a hundred germs are floating about in a room containing two thousand cubic feet of air. There is one germ for every twenty cubic feet. Naturally the germs will be most numerous in the immediate neighborhood of their source, the person of the sufferer; but, excepting this one place, they may be pretty equally distributed through the room; or they may be very unequally distributed. A draught across the bed may carry them now to one side, now to the other. The mass of them may be near the ceiling, or near the floor. In a given twenty cubic feet, there may be a dozen germs, or there may be none at all. One who enters the room may inhale a germ before he has been in it ten minutes; or he may remain there for an hour without doing so. Double the number of germs, and you double the danger. Diminish the size of the room by one half, and you do the same. Keep the windows shut, and you keep the germs in; open

them, and they pass out with the changing air. Hence the importance of free ventilation; and hence one reason why fever should be treated, if possible, in large, airy rooms. Not only is free ventilation good for the sufferer, but it diminishes the risk to the attendants.

We see in this, too, the reason for banishing bed-curtains, carpets, and all unnecessary furniture from the sick-room in cases of contagious fever. The germs are apt to adhere to such articles, and so make them the means of conveying the disease to others.

All organisms consume in their growth nitrogen and water. Those with which we are now dealing are no exception to the rule. Growing in the system, they must get these elements there. But nitrogen and water are the chief materials required for the nutrition and repair of the various organs and tissues of the body. The propagation in it of millions of organisms, having wants identical in the main with those of its own tissues, must cause serious disturbance. And so it does. This disturbance declares itself by that aggregate of phenomena to which we apply the term fever.

An organism which thus grows in and at the expense of another is a parasite. One of the peculiarities of parasites is that they flourish, not in any part of their host, but only in some particular organ or tissue, which is called the *nidus*, or nest of the parasite. The organisms with which we are now dealing (the poisons of the eruptive fevers) show similar peculiarities. Each has its own nidus, its own localized habitat, in which it is propagated, and out of which it ceases to be reproduced. The poison of small-pox has its nidus in the deep layer of the skin; hence its characteristic eruption. That of scarlet fever in the superficial layer of the skin and in the throat; hence the rash and the sore-throat of that disease. That of measles in the skin and in the mucous membrane of the air-passages; hence its characteristic symptoms. That of typhoid fever in the glands of the intestine; hence that disease consists of fever and of ulceration of the bowel.

The contagiousness of a given eruptive fever must be directly as the number of germs which, in a given time, pass from the body of a sufferer into the surrounding atmosphere. This, in its turn, must depend on the seat of the propagation of the poison, and on the relation which this bears to that atmosphere. In small-pox, scarlet fever, typhus fever, and measles, the seat of this propagation is the skin and mucous membrane of the air-passages; it is, therefore, in direct, free, and constant communication with the external air. The poisons of these diseases are accordingly freely given off into the atmosphere of the room in which the sufferer is, and they themselves are highly contagious.

In typhoid fever, the poison is propagated in the bowel, and is thrown off with the discharges from it. It thus passes from the system in a manner and in a combination which insure its speedy removal from the neighborhood of the sufferer. The typhoid-germs are there;

but they are mingled with discharges which may be removed, and as matter of course are removed, before the germs can pass off from them into the surrounding atmosphere. The seat of the propagation of the typhoid-poison has no direct relation with this atmosphere; germs can not pass directly from the one to the other; the disease, therefore, does not display the property of contagiousness.

The danger in typhoid fever is not contact with the person of the sufferer, but contact with his stools. If these are properly managed and disposed of, the disease can scarcely spread. But, if they are allowed to pass into drains which are imperfectly trapped, inadequately ventilated, or insufficiently flushed, or if they are carelessly thrown on the ground, or allowed to percolate through the soil into drinking-water, then one case of typhoid fever may give rise to many others. The occurrence of a case of typhoid fever in a house is a sharp test of the efficiency of its sanitary arrangements. If these are perfect, and the stools properly managed, all will go well; if they are defective, one case may give rise to many others. But the communication of the disease is not direct, by contact; it is indirect, by infection of drinking-water, or of an atmosphere which may be remote from the person who is the source of the poison. A case of typhoid fever is introduced into a locality. The stools are thrown out on the ground or into a cesspool, whence they percolate through the soil into a well. The person who drinks water from that well runs a greater risk than one who sleeps in the same room as the sufferer and is in constant attendance on him.

The practical outcome of all this is—1. That the mother may nurse her son, the wife her husband, the sister her brother, without the risk involved in the case of typhus or scarlet fever; and, 2. That there is little or no danger to the other inmates of the house, if its sanitary arrangements are perfect and the stools properly managed.

On this view of the nature and mode of action of contagion, it is easy to see, not only how the process of contagion and its varying phenomena may be explained, but how, by care, much may be done both to prevent the poison from passing into the atmosphere and to diminish its chance of acting after it has got there. We have only to consider what is the chief channel by which the contagion gets exit from the system, to know by what means we are most likely to prevent its passing into the surrounding atmosphere. In typhoid fever the poison passes off in the stools; and what we have to do is to see that these are promptly and properly disinfected and disposed of. In small-pox, scarlet fever, typhus fever, and measles, it is eliminated by the skin, and we can not altogether prevent its getting into the atmosphere; but, by frequent sponging with some disinfecting fluid, or even with plain water, many germs may be arrested in their outward course.

The apostolic mode of anointing with oil is also an efficacious way of fixing and arresting the germs: it is specially useful during conva-

lescence from scarlet fever in fixing the particles of peeling skin, which are a source of much danger. They are dangerous because they contain the germs which have been produced in them. What we see happen in the larger particles of skin happens also in many of the much smaller particles of contagion.

By the adoption of these various measures, by rigorously isolating the sufferer, and by having the room well ventilated, much, very much may be done to check the spread of contagious fevers. The matter of which organisms are composed is one of the most perishable things in nature. Contagion is no exception to the rule. By exposure to the air much of it is destroyed; hence such exposure is one of the best of all disinfectants.

Sanitary science has done much to show us how some of the diseases with which we are now dealing might be extinguished, and how all of them might have their prevalence greatly diminished. It rests with those who have such ailments in their houses to carry into effect the measures calculated to destroy and get rid of the poison, before it has had time or opportunity to be a source of danger to those around. But the adoption of proper measures presupposes a knowledge of the nature of the poison with which we have to deal, and of the manner in which it passes off from the system. In not one is this knowledge more necessary than in typhoid fever; in not one are the measures which such knowledge dictates more easily applied, or more likely to be effective. But, to regard typhoid fever as contagious in the sense that small-pox and typhus fever are so, is to divert attention from the true source of danger, to lead to the adoption of measures which are uncalled for, to the neglect of those which are urgently required; is to cause unnecessary concern to the sufferer and his friends, and to deprive him and them of the mutual comfort and solace which a little daily intercourse affords. The peculiarities of the illness may be such as to make it right to exclude the friends; but isolation is not requisite for the same reason that it is so in typhus.

One more point. The receiver as well as the giver of the poison has something to do with the determination of its action. Not every person into whose system a germ passes necessarily suffers from its action. A man who has had small-pox, for instance, is no longer susceptible to the action of its poison—and why? Not because the poison can not get into his system, for we can make sure of that by inoculating him with it, but because, during the first attack, the nidus, the special material necessary to its propagation, was exhausted, and has not been reproduced. This immunity from a second attack is a general characteristic of the eruptive fevers; individual exceptions there are, but the rule is that one attack confers immunity from a second.

A germ does not act unless it reaches its nidus; it may enter the system, make the round of the circulation, and again pass out without ever coming in contact with its nidus, and therefore without doing harm.

The more widely the nidus is diffused, the less likely is this to happen. In small-pox, in scarlet fever, and in measles, the nidus is widely scattered. In none of them is a germ likely to make the round of circulation more than two or three times, without being conveyed to its nidus.

In typhoid fever the nidus is situated in a limited portion of the bowel, the sole route to which, by way of the circulation, is through an artery the size of a crowquill; a typhoid-germ may be taken in through the lungs, and may make the round of circulation two or three dozen times, without being likely to enter that particular vessel. The more often this may occur, the greater the chance of its being thrown off from the system without acting. But, if the typhoid-germ be taken in through the digestive organs, it is brought into direct contact with the seat of its nidus, and can scarcely fail to act. Hence the great danger of drinking water or milk contaminated with the typhoid-poison.

The glands which constitute this nidus are not equally prominent and active all through life. In infancy they are quite rudimentary. At two or three they begin to grow, and gradually increase in size, and presumably in functional activity, till the age of puberty. They continue to be very distinct for twenty or twenty-five years. After forty they begin to get less, and gradually diminish till at seventy they have dwindled away so much that they can no longer exercise any active function. Their period of prominence and of functional activity corresponds exactly to the period of susceptibility to the action of the poison of typhoid fever. That disease is extremely rare in infancy; from two to six, or seven, it is more common, but is generally very mild. At fifteen or sixteen commences the period of greatest liability to it; and from that age until thirty-five and forty it is very common and very fatal. After forty-five it begins to decline both in frequency and severity; and goes on declining as years advance, till at seventy the liability to it may be regarded as practically worn out. When it occurs in advanced life it is generally mild; but its occurrence then is as rare as in infancy. Increased and diminished susceptibility to the action of the poison of typhoid fever correspond exactly to the increase and diminution in the size and functional activity of the glands which constitute its nidus.

The insusceptibility to the action of the poison, which is naturally and slowly developed in old age, is artificially and rapidly produced by the destruction of the nidus during an attack of the disease.

Using the word contagious in its proper sense of communicable by contact, and regarding the typhoid-poison as a parasite whose nidus is in the glands of the bowel, we are led to the conclusion that the disease to which it gives rise, though undoubtedly infectious, can scarcely be contagious. We know from our experience that it is not so; for it never spreads in hospitals, and attendants on the sick suffer no more than other people.

The difficulty has been to reconcile these facts with the reproduction of the poison in the system. The source of this difficulty is the rooted belief that this reproduction takes place in the blood. On this view all the eruptive fevers ought to be equally contagious. But let us once adopt the view that the poisons of the eruptive fevers are parasites, and that the seat of the local lesion of each is the nidus of its parasite, and therefore the seat of its propagation, and the whole difficulty vanishes. We at once see why each has a definite period of duration, why one attack protects against a second, why each has its own characteristic lesion, why each presents such varying degrees of severity, and why they possess different degrees of contagiousness. —*Abridged from the Nineteenth Century.*

HANOVERIAN VILLAGE LIFE.

By WALTER NORDHOFF.

THE Hanoverian village of E—— lies a few miles distant from a famous university town, in a district which still maintains many old-time customs, and which presents, therefore, a curious image of German rural life thirty or forty years ago.

The approach to E—— from G—— is very pretty. The thorough culture of German fields and the absence of fences make a rural prospect especially pleasing to an American. At the foot of a low hill, and completely embowered in green, lay E——, with nothing of it visible as we neared it except the church-steeple and the red-tiled roofs of the principal houses. My lodgings were in a house near the church; my room—the best in the house—commanding a view and smell of the stable and barnyard, with its manure-heap, which we passed on our way from the street to the front door. I still wonder why in E—— the parlor, dining-room, and best sleeping-rooms are made to face the barnyard, while the kitchen and servants' rooms look out upon a pretty garden in which the family spends most of its summer days.

The commune or village of E—— has about six hundred inhabitants. It has no manufactures, and all its people, even its officials except the clergymen, live either partly or entirely upon the produce of the soil tilled by themselves. The tilled land is very minutely subdivided, the pasturage and forest-lands being held and used in common, while the laws and customs governing this use, and the general system of land tenure, culture, and improvement, are in many ways curious to an American.

The land belonging to the commune or village of E—— is divided into tillable, pasture, and wood land. The tilled land amounts to

eleven hundred and forty acres, and is owned in plots of from thirty to fifty acres. The *Bauermeister*, or head of the village, owns one hundred and fifty acres, but he is exceptionally wealthy. The church-lands are two hundred and eighty acres, and there are also two hundred and ten acres owned by a noble family, non-resident. The tillable church-lands are let to factory and railroad laborers in small plots, and the women of these tenants form a part of the general laboring force in the harvest-season.

Twenty acres is the least amount of land that a peasant, who lives on the produce of his farm alone, can cultivate profitably in this region, and the living thus obtained is so miserable that those who own so little generally eke out their subsistence by renting land from richer farmers. Sixty acres of the land around E—— have been set apart, by old usage, as common, on which those of the villagers who own "village rights" graze their animals, and from which they get clay and stone for building and a certain amount of hay for winter use. The extreme subdivision of the land around E—— is the result of the laws which govern the inheritance of land in the province. At the death of the head of the family his land is divided equally among his children, his wife having first taken out of the estate the amount of money or land she brought her husband at marriage, and, in addition to this, a part equal to the share of one of the children. The mother's property at her death goes to the children in the same way.

Church-lands can be sold when the consent of the minister, church trustees, and church government has been obtained, but such sales rarely take place. Land belonging to the commune as commons can not be sold unless special authority has first been given by the state.

The highest value I heard set on any land in E—— was three hundred dollars an acre for a garden-spot in the village itself. Land near E—— is not worth so much as near some of the towns around it, because it has never been *verkoppelt* or "married," as the process is called, by means of which a peasant obtains one compact farm in exchange for a dozen or more widely scattered, small fields. This *Verkoppelung* and the laws and customs which make such a process necessary show so much of the German farmer's mode of life that I will explain the manner in which it is carried out: In accordance with the laws which govern inheritance, each daughter must receive either at her marriage or at the death of her parents a certain share, varying with the number of children, of all the land belonging to her parents. The chances are, of course, very much against the land which she thus inherits adjoining that of her husband, so that, in the first generation, the family have two fields which may be a mile or two apart. Now, when this couple die, each one of their children receives its share, not of the whole, but of each field owned by the parents. Suppose this process to go on for a century, and it will be readily understood that a peasant may own thirty or forty fields, each containing but a small

fraction of an acre, and no two of which lie together. To remedy the evils of this system, Verkoppelung commissions were created for each province by the state, which also undertook the draining, irrigation, and laying out of roads through the land on which they worked.

Any landholder in a village may, by merely notifying the district magistrate, call a meeting of the farmers to consider whether the land of the village shall be verkoppelt, but, if less than half the landowners respond to the call, or if a majority are against the measure, the caller of the meeting has to pay its legal expenses. If half the landowners respond, and the question is favorably decided, notice is at once sent by the magistrate to the general Verkoppelung commission. This commission decides whether the village meeting did its work in a legal way, and, if the requisite amount of red tape proves to have been used, appoints an inferior commission to see that the roads, canals, and ditches are properly placed, and to be responsible for the honest performance of the work to be done. The first work of this commission is to register the value of the land owned by each farmer; then the land is ditched, and canals and roads are built. After the work is finished, all the land of the village is divided into a certain number of grades, generally eight, the first of which contains the best farming-land; the remainder containing continually poorer and poorer land until in the last are placed the mountain pasture-fields. Upon each one of these subdivisions a value is then set by the commission; the total value put upon the land being, of course, equal to the value of all the village land before the Verkoppelung. The commission then retires, and a farmers' meeting is called to ratify its valuation. If at this meeting any one objects to the value set upon any piece of land, his objection is noted and sent to the general commission, and, if thought to be reasonable, the land is valued anew; but, if the question is decided adversely to the objector, he has still the right to refuse to take the land in dispute, and it can not be forced upon him. If, however, a considerable number of objections are made to the valuation, a new inferior commission is appointed, this time from among the farmers who have objected to the former valuation; and the decision of this last commission is final, no appeal being allowed.

The preliminaries having been successfully adjusted, the general commission then allots to each farmer arbitrarily an amount of land equal in value, although perhaps not in quantity, to that he had before his land was taken. Whenever there is pasture-land among that belonging to the village, each farmer receives, after the Verkoppelung, a certain amount of it; in which case his farm lies in two parts. The average cost per acre of the whole process is about five dollars, and this is assessed on each peasant according to the value of the land he receives. In case any farmer can not pay his share of the expenses, his land is sold, just as it would be for unpaid taxes.

When a person has land to let, he sends notice to the town crier,

who then parades the streets, beating a drum and stopping at each corner to announce that such a person has so much land which will be rented on such a day. On the day mentioned, all those interested meet in the public square, and a lawyer, or the village magistrate, states to the assembly the quantity and location, and the general terms on which it will be rented. He then auctions off the lot field by field. The highest price paid per acre per year, in E——, is seven dollars and fifty cents, and poor land rents as low as twelve cents a year. Leases run from six to eighteen years. Each renter of land deposits with the magistrate, at whose office his lease is drawn up, a sum of money equal to the rental of the land he has taken for one year, and in most cases for two years. The money thus deposited remains with the justice during the whole term for which the land is rented, and is then returned to the depositor if he has paid everything due the landowner. The amount of ready money thus required is so great that farmers can seldom afford to rent more than a few acres of land. Owing in part to the excessively high rent paid for land, and in part to this deposit, farmers can make little more than their living expenses from rented land. In fact, even those who own their land are glad to get through the year without having to run in debt or to deny themselves some of the necessaries of life.

Without exception, the methods of cultivation employed around E—— would be thought in this country old-fashioned and inefficient. Even such simple tools as the scythe and cradle are seldom used, almost all the grain being cut handful after handful with a sickle, and then carefully laid out to dry before being bound into small bundles. A whole family works day after day over the grain, handling each straw at least three times, and yet showing no trace of mental fatigue at the (to me) awful monotony of the work. I could only wonder at the temerity of a government which dares to educate a people before whom, from their childhood, lies nothing but the prospect of drudgery so constant and so stupefying. The farmers, to economize time, generally do their threshing at night, rising for this purpose at twelve or one o'clock, and working at it until it is time for their regular day's labor to begin.

Grains of different sorts and leguminous plants are the main crops grown around E——, to which each farmer adds whatever he needs for his own use. In most cases, also, they do a little market-gardening for the neighboring city market. According to the method by which all the land belonging to the community of E—— is cultivated, the whole arable soil of the village is divided without regard to private ownership into three parts, called Winter, Sommer, and Brachfeld, or fallow. In the Winterfeld are grown those crops which are planted in the fall, or early in the spring—being for E—— mainly rye and wheat. The Sommerfeld has the spring-sown crops, of which barley and oats are good examples. The Brachfeld is, as its name de-

notes, allowed to lie entirely fallow, or at most is used for pasture, or for the growth of such light crops as esparsette and the legumes. Next year the Brachfeld of the former year becomes Winterfeld ; the former Winterfeld is used for Sommerfeld ; and so on year after year, and century after century.

A part of the commune-land is used as pasture, and on it each person holding a village right may pasture a certain number of cattle, sheep, pigs, and geese. A second part is meadow-land, and every twelve years this is divided into as many parts as there are holders of village rights, and each one receives a share, of which he has the exclusive use until the redivision at the end of the duodecade. Still a third part of the commune-land is planted with fruit-trees ; the produce of which is sold for the benefit of the communal treasury. A fourth, and largest part, is planted with forest-trees, and from it each person receives yearly a certain amount of building and fire wood.

During the months when farm-work is possible the peasants in E—— rise between four and five, and, after a breakfast of coffee, sausage, and bread, go at once to the fields. At half-past nine or ten the whole family sit down in the field and eat black bread, washed down with a kind of coarse brandy called schnapps. Then work goes on again until twelve, when, if the day is hot, they return home and rest for an hour or two, making their noonday meal of bread and the remains of the coffee prepared in the morning and kept warm on the embers, or, if wood is scarce, by wrapping the coffee-pot in the bedclothes! After their return to work, an afternoon meal of bread and schnapps is eaten at half-past three, and an evening meal of bread, coffee, and a warm soup, when they stop work at seven or eight. Constant toil of this sort leaves but little time for reading or self-improvement, and only six papers are taken in E——, not more than twelve or fourteen persons in all reading them. These weeklies and a few story-books, loaned out by the pastor, are the only reading material of a village of five hundred and ninety-one souls. The bread eaten by the peasants is made of coarse black flour, baked once or at most twice a month, and eaten without butter. On Sunday morning a little beef or mutton is sometimes eaten by a few families, but otherwise no animal food is taken except in the form of sausage-meat. Children do not work in the fields until about ten years of age, nor is much work done by them for five or six years later, as from six to fifteen or sixteen years of age they are compelled to attend school. In summer, from June 24th to September 29th, there is no afternoon session of the school, and the children then help in the harvest. The toil of a peasant being so constant, is also done slowly and poorly. A wood-sawyer, for instance, holds and works his saw with only one hand, and draws a breath between each stroke.

A compulsory school law in the province of Hanover forces the peasants to study during ten years of their lives, and during this time

a little reading, writing, and arithmetic is acquired; but beyond this is and a slight knowledge of High German they do not advance. Cleanliness is not a peasant virtue in this region, and perhaps I had better say nothing on the subject, further than that the pig is at all times a welcome member of the highest village society, and generally goes into the house by the front door.

All work and no play makes the peasant a dull fellow, and the little education he gets does not help him much. Many stories of their blunders are current, involving oftenest the local Dogberries. To this sort belongs the sign said to have been posted in a stable in G——, and which notified the stablemen that "it is forbidden to feed the horses or cows with lighted pipes or cigars." A trespass notice, still to be seen near E——, gives perhaps the best idea of this sort of muddle-headedness. Written in Plattdeutsch, it gives the warning: "This road is no road, but he who will travel it notwithstanding is fined four marks and two days in jail; the informer to receive half." Laws are so strict and well enforced that there are few crimes. Such as do occur in E—— are mainly fights caused by liquor and family quarrels, which the pastor commonly has influence enough to settle.

Owing to the small land-holdings there is in E—— no distinct class of what we in this country call farm-help; but, when a man has not money enough to hire land in the ordinary way, he goes to a farmer and asks for six or eight acres of land, agreeing to pay so much rent, and giving no deposit, but binding himself to work for the farmer at rates much below those usually paid day laborers—twenty-five cents a day or thirty-five cents for cutting an acre of grain being the prices paid to such boundmen.

House-servants are employed in E—— only by the minister. They are hired at Easter, or on the 16th of November, and one year is the usual length of the term for which they engage. Housemaids receive from fifteen to twenty-five dollars a year, and a present of twenty yards of linen and a pair of shoes; it is also customary to give them small money fees once or twice a year if they have done their work well.

I ought to have explained before, that the village, besides being a collection of people assembled together for protection and to afford church and school facilities, is also a commune in the sense that it is a closed corporation without the power of self-extension or contraction. The village can and does own property, and hires men to do village work, as, for instance, to take care of the cattle owned by members of the corporation. This system of land tenure is said to have originated in the following way: In the earliest times a single family held all the land around it in common. At that time all the land was divided, as it still is, into three parts, to provide for the alternation of crops and the resting of the land. Each man then received his share of the land for a year only, a redivision being made at the end of each season. As time went on, the term for which land was allotted increased, until

gradually the principle of private property was introduced and the ownership of land became fixed. But this change did not affect pasture or forest land. The result of all this has been the retention of the communal idea in regard to the so-called village rights which belong to the *citizens* of E——, but not to all its inhabitants. There are only sixty-six of these *rights*, and this number can not be increased or diminished, so that only a small part of the six hundred inhabitants of E—— are citizens. Each one of the *rights* can be halved—thus, of course, also halving the privileges of the possessor, but the subdivision can go no further. Each *right* gives its possessor the privilege of grazing a certain number of sheep, cattle, geese, and swine on the public pasture; of mowing a certain amount of meadow-land, and of getting stone and clay for building from the village pits, besides a considerable amount of wood each year from the communal forest. Village *rights* have thus a considerable value, and are sold at prices ranging from two hundred and twenty-five to three hundred dollars each. In order to possess a *right* a man must own a house in the village, and he can not own more than one *right* unless he increases the number of houses he owns in the same proportion.

Since the number of *rights* can not be increased, and since each one can only be halved, there must, of course, be numbers of people in the village who are not corporators. Such persons have none of the privileges belonging to the rest except the permission to graze cattle on the common pasture when they have paid to the commune authorities a fixed price per head for each animal thus fed; nor have such persons any vote when communal affairs are to be passed upon.

E—— is entirely independent of the neighboring city of G——, but offenses against the law are tried by an inferior court sitting in the latter place. Each male in E—— who has attained the age of thirty years, and who is not a pauper or criminal, has a single vote in the election of those officers who are to govern his village. These officials are, first, a Bauermeister, having the combined powers of sheriff and town clerk; under him are two deputies and a Council of twelve men, all elected for a period of six years. The Bauermeister, who is generally one of the wealthiest and most intelligent of the citizens, keeps the village accounts; makes the state and military reports; registers births, marriages, and deaths, also sales and rentals of land; places criminals and insane in safe keeping; receives applications from the village poor; gives notice of the commencement of military service, to which each young man is bound; and reports to the state at specified times upon communal and village affairs. He is also President of the Council and of all village meetings. For all this hard work he receives only forty dollars a year, and his assistants get nothing but the barren honor of election. Over the Bauermeister is placed a state official who has control of a number of villages. Provincial and village taxes are collected by an officer elected for a term

of six years, who receives about thirty dollars per annum for his services.

E—— has two foresters appointed by an imperial forester, under whose control they are. These officers receive about forty-five dollars a year, and for this sum must decide all matters in regard to the cutting or planting of trees; must see that no wood is stolen, and during the wood-cutting season must prevent any one cutting more than his share, and see that only marked trees are cut. They must, moreover, preserve all the game in the forest for the use of that person to whom the right to kill game has been let.

The pastor of E—— is supported by the rental of two hundred and eighty acres of land, belonging to the church, and his income is also slightly increased by marriage, burial, and other fees. Since the minister is the only cultivated man in the village, he has of course great influence over all village affairs, and acts as peacemaker in all disputes or quarrels. To him each farmer comes as occasion demands for advice or instruction, but he never visits his people, except when severe illness or death calls for his good offices, nor have I ever seen a peasant enter the parsonage, except when called there by business. This total separation of the pastor from his flock seemed to me to make the church a mere formal affair incapable of doing much good, yet I could not wonder at the refusal of an educated man to associate with the peasants. Village ministers are appointed by the church consistory, and hold their places for life, unless they break some church rule or preach false doctrine. They are always university men, and are generally well-read, but their views are apt to be narrow—Darwin being looked upon as an arch-fiend, and science, in so far as it does not agree with literal translations of the Bible, as "science falsely so called." They revolve in a little circle, independently of all the secular world, around some bishop or church dignitary. Their social life consists of an interchange of afternoon and evening calls, at which coffee is drunk, and the world, the flesh, and the devil, discussed in a very innocent way; occasionally this monotony is interrupted by a birthday party or a church celebration. The latter are, however, a delusion and a snare to outsiders, as each preacher goes with a sermon or two in his pocket and with his mind made up to read them. As a consequence of this, and of the German peasant's love for sermons, I once stood up in a crowded church from 7 A. M. to 5 P. M., with only an hour's intermission for dinner, listening to an endless series of sermons, varied only by a change of speakers! I left the church at five, but was afterward told that there was an evening session and that the preaching went on for three days.

The pastor is president of a board of trustees, consisting of four church-members, by whom all church expenses are audited, and also of a school board, of four electors and the teacher, which controls school matters. The members of these boards, with the exception of the

minister and teacher, are chosen for six years by the votes of all the male church-members.

The schoolmaster unites in one person the duties of sexton, grave-digger, and bell-ringer. All teachers must have passed an examination held by the state, for which they are prepared by some years' study at preparatory schools and a three years' course at one of the eight normal schools in Hanover. In order to enter these schools, the applicant must be eighteen years old and be able to pass an examination in the elementary studies. Teachers earn from one hundred and seventy-five to two hundred and twenty-five dollars a year. In E—— the teacher received eighty-seven cents a year from each of his one hundred pupils, fifteen dollars a year from the church for his services as sexton, besides fifty cents for each adult's and twenty-five cents for each child's grave dug by him. From the state he got eighty-two dollars, and from the village seven dollars and fifty cents a year, with six acres of good farming-land and a house. All the books and maps I saw were of the most old-fashioned sort, and the teacher was drunk whenever he had money enough to buy schnapps. The church consistory appoints and removes the village teachers throughout Hanover. Teachers are not considered socially equal to nor do they associate with ministers. With the teacher ends the list of village officers, and next come those communal servants for whom we in this country have no equivalent. In what follows, the distinction between village electors and commune citizens or corporators must be borne in mind. Those that I have called electors comprise all males over thirty who live in E——, while there are only sixty-six citizens of the commune. Electors have no rights except that of voting for village officers, while village corporators possess many valuable privileges, a list of which I have given above. Communal servants consist of a shepherd, a cow-herd, who also looks after the swine, and a gooseherd, who, in addition, is town-crier, and runs on errands for the Bauermeister. All these men are elected yearly at a meeting of the corporators. Such places are much sought after, but do not descend from father to son. Each full corporator may send out daily with these herders four cows, six sheep without lambs, four pigs without shoats, and twelve geese. The animals are collected every morning at stated hours by the herders, who go through the streets playing peculiar airs on their horns, at the sound of which those corporators who wish to send their animals out turn them into the street to be collected. In the evening the animals are brought back from the pasture by their herders, and turned loose in the village to find their own way home. Sheep, however, are not returned to their owners each night in this way, but remain with the herder during the summer season. For their labor the herders receive very little ready money, most of their salary being paid in agricultural products. Each of the herders receives a house and a quarter of an acre of land from the commune. In addition, the shepherd has the

privilege of pasturing fifty sheep of his own, and receives seven dollars and a half a year from the commune and about fifty dollars yearly in grain from the citizens. The cow-herder makes about forty dollars a year, and the goose-herder receives a hundred loaves of bread from the citizens and twenty-two dollars in money from the commune, for which he must do all the town-crying and go daily for the orders of the Bauermeister.

I could get very little information in regard to the modes of taxation of the village, each person being willing to tell me what taxes he paid but no one seeming to know just how they were assessed. A farmer with forty acres of land paid, the year I was in E——, five dollars as land-tax, three dollars as poll-tax, one dollar as house-tax, and four dollars as village-tax. He would also, if he had kept a shop or inn, have had to pay a special license. Incomes of less than one hundred and ten dollars are exempt from taxation. Ministers and teachers pay state but not village taxes. The pastor of E—— paid a tax of nine dollars on his income of four hundred and fifty dollars, and a land-tax of twenty-four dollars on two hundred acres of land. Communal taxes vary greatly in rate according to the wealth of the commune. Some communes, which own valuable mines or forests, not only exact no tax from their citizens, but divide annually a surplus among the corporators. A case of this sort is rare, but it is not uncommon to have most of the communal taxes paid by the sale of wood from commune forests.

Almshouse accommodations are so poor and the food and treatment so bad that but few of the inhabitants of E—— feel pauperism to be their vocation. Only one villager receives food and shelter from the village, and a second food alone. Their provisions are obtained by going from house to house in the village, each house being bound by law to provide food for the paupers so many days each year. I asked why the poor-house was not repaired, and was told that the peasants had purposely built it poorly, fearing that if it were comfortable it might encourage pauperism in the village. The poor are supplied with clothes either from the church or village treasury according to circumstances. A residence of two years in a village compels its inhabitants at the expiration of that time to support the applicant, nor can he be forced to do any work in return for his living. The one pauper in E—— was so distressing to the eye that I never passed him if I could avoid it. Blind and lame, hatless, coatless, shoeless, and covered with the mud in which he had slept, he seemed, as he crept from fence-post to fence-post, muttering curses on those who passed without giving him alms, to be forsaken alike by God and man. I can imagine him being, in the words of a dying tramp, "glad to have a hell to go to," but I can not believe that any moderately respectable imp would touch him without the aid of a pair of tongs. A gift of one cent would cause him to bless you until he had reached the nearest

dram-shop; more than this I never dared to give, for fear of causing an inroad of beggars upon the village.

An imperial forester, with one or more deputies in each village of his district, has complete control of all the woodland in his circle. By him it is decided how much wood shall be cut each year for the use of the commune or corporation, and without his consent not a stick can be cut in any forest of his district. The commune of E—— owns fifteen hundred and thirty-eight acres of land, which has, since the settlement of the village many generations ago, been planted in forest-trees. None of this forest-land has ever been stripped of its trees and devoted to agriculture, with the exception of a small part, which, on account of its position near a much-traveled road, served during the Thirty Years' war as a refuge and place of ambush for brigands and highway robbers. This was, toward the end of the great war, cleared and the land divided among the corporators. The forest-land belonging to E—— is divided into forty parts, one of which may be cleared each year. On account of the large amount of extra labor caused by the keeping up of nurseries, but few villages plant the land cleared by them each year, most of them allowing the natural growth to spring up on the cut portions. Although the natural growth of wood on which E—— depends for its supply does away with the need for a large nursery, the corporators are yet compelled to keep up a small one, in order to plant high, wind-swept ridges where no seed has lodged. This nursery, or *Baumschule* as it is called, is planted and kept up by the labor of all the corporators. As a general thing, only two days out of the year are spent by each citizen at commune work. In the fall a meeting of the corporators is called, and it is then decided when and how much wood shall be cut. The imperial forester is at once notified, and, in company with the village forester, goes through the part which is to be cut that year and marks all trees under an inch in diameter except those which, from their fine form or good situation, seem likely to make first-rate timber. The whole of the woodland to be cut is then divided into sixty-six parts, and each corporator receives a part, allotted by chance, on which he at once goes to work and clears off the brush and marked trees. When this has been accomplished throughout the whole tract, the imperial forester is again called, and goes through the forest, marking all trees not large enough for building timber, and which are so warped, decayed, or top-killed as to be unlikely to grow into good timber. These trees are then divided as before, and each citizen cuts and carries away his share. Then, for the third and last time, the forester goes through the tract, and marks all the large trees which seem to be hollow-hearted or to have stopped growing. These are then divided and cut like the rest, with the exceptions that the oaks are first stripped of their bark to be sold to tanners for the benefit of the commune, and that the teacher and minister get none of this large wood because, the peasants say that, when a

parsonage or a schoolhouse must be built, it is done, not by the minister or teacher, but by the people. The oak-bark is often worth more than all the rest of the wood of a forest. In starting pine-forests the cones are planted thickly in furrows, and, after the first weeding-out, are left untouched for ten years, at which time alternate trees are cut. This process is repeated every five years, till at the end of thirty years all the trees are cut; the successive cuttings being divided among the corporators.

When any one wishes to build a house in E——, he sends word to the village court, describing the kind of house and where it is to be constructed. Notices are then posted in the village, and, if no one sends written objections to the court before the expiration of fifteen days, the building is allowed, and can not be interfered with. It will be seen that the population of E—— consists of two classes: the few more fortunate, who possess village rights, and draw from these an income which considerably increases their comfort; and the less fortunate, but more numerous, who possess no share in the communal property. But no social distinction, so far as I could see, obtains between these two classes.

MAPS AND MAP-MAKING BEFORE MERCATOR*

By CHARLES P. DALY, LL. D.

[*ABRIDGMENT OF AN ADDRESS BEFORE THE GEOGRAPHICAL SOCIETY.*]

THE materials for the history of cartography, or the art of map-making, are scanty. I propose to give a brief account of what we knew about it before the time of Gerard Krehmer, better known by his Latinized name of Mercator, who produced a large map of the world more than three centuries ago.

It is generally thought that the art of pictorial representation is older than the art of writing, and, if this be so, it is probable that the art of representation by maps is very ancient. Such delineations are in use among very primitive peoples. The Esquimaux understood the charts of Parry and Ross, and the North American Indians make rude maps, which they find serviceable to them.

One of the earliest things known in the nature of a map is the ground-plan of a town, now in the Koyunjik Gallery of the British Museum, which has been identified by Mr. Loftus as representing with minute accuracy the ground-plan of Susa, the Shushan of the Bible, a city of remote antiquity, situated on one of the streams that flow

* The Early History of Cartography; or, What we know of Maps and Map-making before the Time of Mercator. Address before the American Geographical Society in 1879, by Chief-Justice Charles P. Daly, President of the Society.

into the lower Euphrates, a little to the north of the head of the Persian Gulf, the country whence the people or race came that built Babylon, and founded the Chaldean civilization. The age of this topographical work is unknown, but it is assumed to be as old, at least, as the seventh century before Christ. It represents, in a rude form of design, the plan of the town, its walls, the citadel, the king's palace, and a central square surrounded on three sides by what is either a wall or a colonnade of buildings of uniform character. On the remaining square is a large gateway, and the suburbs surrounding the town are represented as planted with date-trees and interspersed with buildings to the banks of the river.

The Egyptians had maps, although but little is known of them. There is a papyrus preserved in the museum at Boolak containing a map of Lake Mœris, on the Nile. It shows the plan of the basin with its canal, and the position of towns and of certain sanctuaries upon the borders of the basin, with explanatory texts giving information respecting these places. There is also an old Egyptian map preserved at

FIG. 1.—HOMER'S WORLD.

Turin of what is now Wady Alaiki, where the Nubian gold-mines were situated, in the land anciently called Aki-ta. It is a mountainous country, of dreary, sterile, waterless valleys, where men and beasts died upon the roads to these mines. The map shows the mountain-tracts, the rocks, and the places where gold was found, the ore-bearing mountains being marked in red color. It also shows the wells, a temple erected to Ammon on the mountain, and the appurtenances and buildings in the gold-districts. The roads, which had been abandoned, leading to the sea, are also given. "Nothing," says Brugsch Bey, "is

forgotten calculated to give the spectator an idea of the state of the region, even to the stones and the scattered trees along the roads." This description is sufficient to show that the Egyptians knew the value of maps, and that they made and used them. These gold-mines were worked in the reign of Rameses II., and if this map was made at that period, as from the description given of it would seem to be the fact, then it is the oldest map known.

It was very different, however, with their neighbors, the Phœnicians. They were the great maritime nation of antiquity, making constant voyages along the coasts of the Mediterranean on either side, and along the western coast of Europe, as far as Great Britain, and possibly farther. The outlines of a coast once seen would, it is true, be sufficiently preserved in the memory for the practical purposes of navigation; but a people who had extended their voyages so far, who had established so many colonies, and to whom is attributed the invention of the alphabet, would naturally be led to the construction of charts,

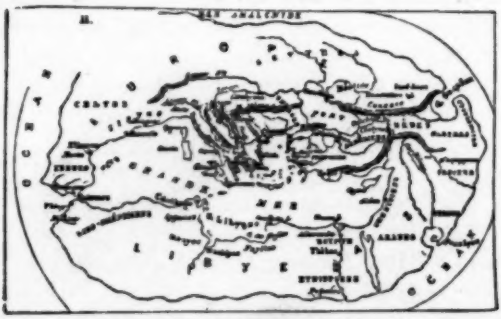

FIG. 2.—MAP OF HECATÆUS ,B. C. 500.

from their utility, as well as maps to give some general idea of the world, of which they knew more than any other people. A jealous commercial policy kept them from imparting their knowledge to others, so that we do not know whether they had maps or charts; which is not remarkable, as we know, in fact, so little respecting them.

It is from the Greeks that we get our earliest knowledge of geographical maps. The first information we have upon the subject is from passages in Herodotus and Strabo. Strabo says that Anaximander, who was born B. C. 612, was the first who represented the world upon a map. Diogenes Laertes ascribed to him the invention of geographical maps, and also of the gnomon. But this he probably introduced into Greece, as it was in earlier use among the Chaldeans. Herodotus says that Aristagoras, when he went (504 B. C.) to Cleomenes, the King of Sparta, to induce him to invade Persia, produced before the Spartan king "a bronze tablet, upon which the whole circuit of the earth was engraved, with all its seas and rivers."

Hecatæus, who lived in the same century with Anaximander, is be-

lieved to have corrected and improved the map drawn by Anaximander. Hecatæus was, for his time, an extensive traveler. He was well acquainted with Egypt and Western Asia, and embodied the information he had collected in his travels in two geographical works, that have not come down to us, which were of great authority for several centuries after his time.

What these early maps were we do not know, but can form a reasonable conjecture. The earth at that time was supposed to be a flat circular plain, or disk, the broadest part being from east to west, which was entirely surrounded by an ocean, or great river, that washed it upon all sides. In about the center of this plain Greece was supposed to be situated. The great central sea of the inhabited region was the Mediterranean. The farthest point known at the west was the Straits of Gibraltar, then called the Pillars of Hercules. The southern part comprised the north of Africa as far as the deserts; while the region north embraced the countries bordering upon the Mediterranean, and an unknown hyperborean land farther to the north, with the Euxine and Caspian Seas at the northeast. The farthest eastern point known was about the western limit of India. This was what would then be contained in a map as a representation of the earth. The sun was supposed to pass under and around this flat plain, which was then the mode of accounting for the changes of day and night. The space beneath was supposed to be a great vault, called Tartarus, the abode of the spirits of the wicked among men, as the region corresponding to it, above the plain, was the heaven, or abode of the gods. The unknown region beyond the Pillars of Hercules was filled up with creations of the fertile imagination of the Greeks. To the northwest and

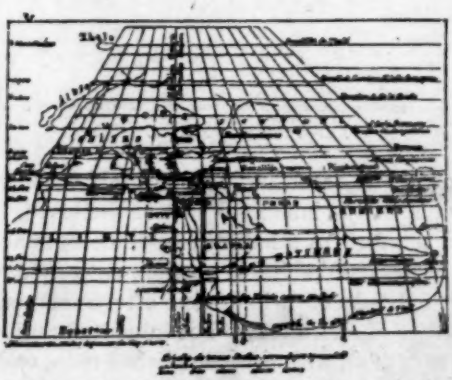

FIG. 3.—HIPPARCHUS, 100 B. C.

north were the Cimmerians, a people living in perpetual darkness; and the hyperboreans, a race supposed to be exempt from toil, disease, or wars, who enjoyed life for a thousand years in a state of undisturbed serenity. To the west of Sicily were the enchanted islands of Circe

and Calypso, and the floating island of Eolus. A little to the north of the Pillars of Hercules was the entrance to the infernal regions; and far out in the Western Ocean, beyond the limits of the known earth, was the happy region called Elysium, a land of perpetual summer, where a gentle zephyr constantly blew, where tempests were unknown, and where the spirits of those whose lives had been approved by the gods dwelt in perpetual felicity. Here, also, were the gardens of the Hesperides, with their golden apples guarded by the singing nymphs, who dwelt on the river Oceanus, which was in the extreme west, and the position of which was constantly shifted as geographical knowledge increased.

When the idea became firmly fixed in the mind of the learned that the earth was a sphere, it naturally followed among an artistic people like the Greeks that some attempt would be made to give a physical

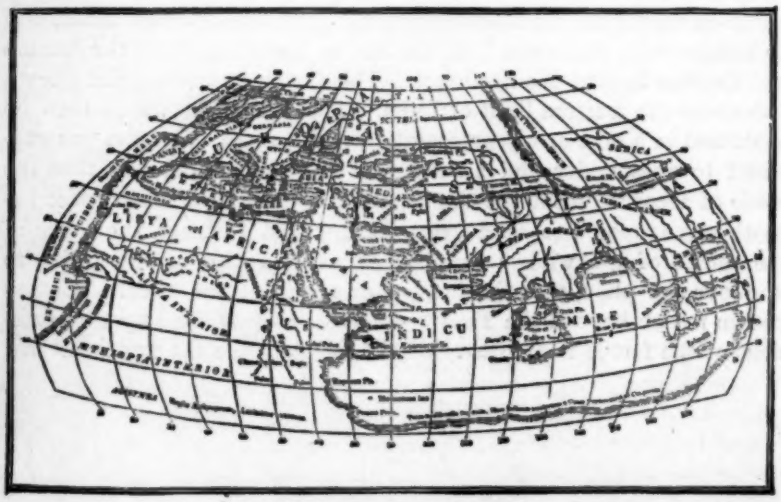

FIG. 4.—PTOLEMY'S MAP, A. D. 150.

representation of it, and accordingly we are told that Crates (B. C. 326) constructed a globe of the inhabited part of the earth, from the Arctic to the Tropic, in the form of a half-circle. The zone about the tropics he represented as an uninhabitable portion, entirely covered by water (a belief which existed for a long time afterward), and the southern half beyond as that of an unknown but inhabited region. Dicearchus the Messinian (B. C. 296), a very accomplished man, and the writer of several geographical works, which are lost, constructed a map of the world in an oval form, which appears to have been highly estimated, and to have been the model upon which subsequent maps were made. It is inferable from passages in the classic writers that the maps in use represented the unknown parts of the world, in conformity to the ideas deeply implanted in the popular mind by the poems of Homer and

from other sources. With Eratosthenes, who died about the beginning of the second century before Christ, the science of geography may be said to have begun. He was the first to apply a purely scientific method to ascertain the magnitude of the earth; for, when a knowledge of the exact circumference of the globe was once obtained, the different countries and places could be arranged in these ancient maps, in their relative position to each other, far more accurately. The distances between places in what was then known as the inhabited part of the earth were previously ascertained by the number of days it took to go from one place to another, derived from the information of travelers and mariners.

To rectify the errors which became more apparent and confusing as the inhabited part of the world became better known, Eratosthenes devised, what has ever since been employed as the most accurate means of determining the circumference of the earth, the measurement of an arc of the meridian. He found a confirmation of the globular form of the earth in the fact that at Syene, in Upper Egypt, upon the tropic, the sun at noon on the day of the summer solstice was vertical—that is, that it cast no shadow, a well at the bottom being enlightened by its rays; while at Alexandria, upon the same day and time, it was distant from the zenith one fiftieth of the circumference of the circle. Eratosthenes obtained by this means the length of what is called an arc of the meridian, or a portion of the curved surface of the earth; and from this he was able, by a familiar rule, to determine the circumference of the whole circle.

The happy idea occurred to Hipparchus of applying to the earth the same method he had used in fixing the position of the stars in the celestial sphere. Regarding the earth as a great circle, which, like any other circle, is divisible into three hundred and sixty degrees, he so divided it, by lines of circles drawn perpendicularly from the poles to the equator, and by parallel lines at equal distances from the equator to the poles, which was the beginning of the division of the globe by lines of longitude and latitude into degrees.

The Romans, in their representation of the earth, at first followed Eratosthenes and Hipparchus. The Emperor Augustus ordered the geographers and designers to prepare for the use of the people a map of the habitable world which should represent fully the extent of the Roman Empire; and, from some fragments that were preserved, it is known that this map was a cylindrical projection of a great circle. The Romans, however, had a map for practical use, which they styled a *descriptive itinerary*, or, as they sometimes called it, "*painted roads.*" This map was in the form of a band, about a foot wide and about twenty feet long, upon which the habitable earth was continuously represented along parallel spaces. It represented pictorially the great routes or roads of the empire, the position of places with the distances between them, the ranges of mountains, and the direction of

rivers. This kind of map was mainly used for military purposes, and was regarded as a map of the world, for the vast extent of the Roman Empire comprised nearly all that was then known of the habitable world.

FIG. 5.—CLAUDIUS PTOLEMY. (From an Old Map.)

Great progress was effected in map-making by Marinus of Tyre, who lived during the second century of our era. He studied with great

care the works of his predecessors, collected all the information that was procurable from travelers and mariners, and produced a geographical work far beyond anything that had preceded it, illustrated by maps which were covered with a network of parallel and meridian lines, cutting each other at right angles, under which the different places were indicated according to their direction and distance from each other. His object was to put an end to the uncertainty about the position of countries and cities, by assigning to every locality or place its approximate latitude and longitude. He divided the globe into sections, each having an astronomical extent of fifteen degrees, and the places falling within these limits he put together in what he supposed to be their relative position to each other. He drew a line due east from the Fortunate Islands, and arranged countries and places in what he regarded as their proper position north and south of this line, so as to bring them alike under the proper zone or climate, as well as under the astronomical section he had devised.

Marinus was probably the first who undertook to combine systematically the results of astronomical observations with those of travelers and mariners in determining geographical positions. There being no delicate instruments to indicate direction, altitude, or time, the latitudes and longitudes ascertained were at first, of course, erroneous. Marinus corrected earlier errors, and accumulated much new material for the preparation of a geographical work which premature death prevented him from perfecting.

The geography of his immediate successor, Ptolemy, which has fortunately come down to us, was written at least within half a century afterward, and, as Ptolemy himself says, was based upon the work of Marinus.

Ptolemy's labor was what in this day we should call editing a new and revised edition of an existing work. Ptolemy was a much better mathematician and astronomer, but evidently very inferior as a geographer to his predecessor. He undertook to correct Marinus's chief error by reducing his projection of the earth, from east to west, from 225° to 180°. In making this geometrical correction, however, he fell into a multitude of errors which, had he been a better geographer, he would readily have detected.

A period of twelve hundred years elapses from the time of Ptolemy to the inauguration, by Prince Henry the Navigator, of Portugal, of the spirit of maritime enterprise which led to the circumnavigation of Africa, and the discovery of the Continent of America. This long interval is marked by the decline in Europe of everything in the form of geographical knowledge, until a state of ignorance was reached in which little interest was felt in any branch of human learning. For the purposes of our inquiry it may be divided into three periods. The first was one of long-continued and nearly incessant wars, during which

the destruction of everything was so great that, when it closed, there was little remaining but fragments of the ancient civilization. This was followed by a period of repose, ignorance, and torpor, to which succeeded another period, ending about the beginning of the fifteenth century, during which a limited few were slowly recovering a portion of the geographical knowledge that had been lost, and dimly groping their way to a true conception of the earth's form and laws.

FIG. 6.—MAP OF THE WORLD, TENTH CENTURY.

But, though geographical knowledge declined during this interval, and from the sixth to the middle of the eleventh century the condition in Europe, except in Spain and in Ireland, was one of almost universal ignorance, there was throughout the whole of the period some attention, at least, given to geography—to the study of maps and to map-making. It was, it is true, very little, and the greater part of it tended more to obscure than to enlighten; but at no time was the interest in the subject wholly extinct. For several centuries after the time of Ptolemy, or up to the separation of the eastern from the western half of the Roman Empire, there was an almost uninterrupted study of geography in the schools of Alexandria, in which the fathers of the Church, the philosophers, the soldiers, and the emperors appear to have taken a warm interest. The maps then in use were itineraries or road-maps, which were very numerous, as they were of service to the soldiers during the wars that were then and which continued long afterward to be waged. In addition to these route-maps, general maps were also constructed, to show at a glance the form and proportions of the habitable globe; and in the fifth century Theodosius II. caused a survey to be made of the provinces of the empire, which occupied fifteen years, from which a large map of the empire was compiled. There was also a geographical school at Ravenna, in

Italy, which, after Honorius (A. D. 404) made Ravenna the capital of the Western Empire, became very active, but the cartographical labors of this school appear to have been limited to the production of descriptive itineraries or painted route-maps. The authority of Ptolemy, during this period, declined. The Alexandrine geographers, no doubt, were better acquainted than he was with Asia, and knew the gross errors he had made in the configuration of countries and the position of places. But there was another and more potent cause that led to the discrediting of Ptolemy, as well as of all the ancient geographers. This was the disposition of the clergy, who for some centuries after-

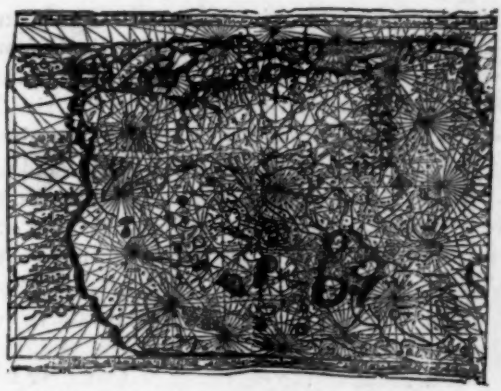

FIG. 7.—ARAB MAP OF THE WORLD, A. D. 1009.

ward were the only learned class, to test all geographical knowledge by the standard of the Bible; and, as the Bible afforded no authority for the opinion of the ancient geographers that the earth is a globe, their ideas and their works were generally rejected as contrary to Holy Writ. In the middle of the sixth century Cosmos, who had been a merchant, an extensive traveler, and who afterward became a monk, was the writer of several geographical works, one of which has survived, in which he maintained that the idea of the earth being a globe was contrary alike to the Scriptures and to common sense; sustaining his views by ingenious arguments, which, in that age, were very convincing. Cosmos was not an ignorant man; on the contrary, his account of the countries with which he was acquainted was accurate and valuable, and it was his topographical knowledge which made him so formidable an antagonist in disputing the rotundity of the earth. "There are," he says, "false Christians, contemners of the authority of Scripture, who dare to maintain that the earth is a sphere. I combat this error, derived from the Greeks, by citations from Holy Writ." He then ridicules the idea that the earth revolves in space without axis, or anything to support it, and characterizes the belief of antipodes, or people living on the other side of a round globe, as old wo-

men's tales. Having thus disposed of the anterior belief, he proceeds to give his own idea of the earth, which he says no true Christian can doubt. It was, that the earth was an oblong plain, inclosed at its four extremities by huge walls of immense thickness, on which the firmament or vault of the heavens rested; and that near the north pole there was a high mountain, around which the sun, the moon, and the stars turned, the intervention of which mountain, at certain periods, caused eclipses.*

We have now approached a period when Europe sank into the deepest ignorance, communication between places was broken up through the long continuance of wars; roads were destroyed, there was little or no commerce, for traveling was difficult and dangerous, and people in close proximity knew comparatively nothing of each other. Fortunately, however, this was not the state of things throughout the world. During the period that marks the rise, the maturity, and decline of the empire of the Arabs, or from the ninth to the thirteenth century, geography was assiduously cultivated by them as a science, especially in Bagdad, the capital of the Caliphs, and for a part of that period in Spain. It is to the Arabians that we owe the preservation of the work of Ptolemy, which they translated into Arabic and annotated. They determined the obliquity of the ecliptic, measured two arcs of the meridian, ascertained more accurately the longitude of places in Asia and about the Mediterranean, and enlarged descriptive geography by an account of the countries in Asia over which they had extended their conquests. As early as the ninth century they trafficked in the ports of the Indian Ocean, and had intercourse also at that time with China, through which probably the mariner's compass was brought to the Mediterranean. I may also mention in this connection that the Chinese, according to the statements of their own writers, had maps from a very remote period. These are described as representing the mountains, seas, rivers, lakes, plains, and basins, and were compiled by order of the emperors.

The Arabian geographers prepared an elaborate work (A. D. 830) founded upon Ptolemy. It is lost, but, from the references to it by Arab writers, we know that it gave a description of the habitable earth, and indicated the prominent places in different countries by their latitude and longitude, correcting, in the countries in which the Arabs were well acquainted, the gross errors in longitude of Ptolemy. It is from these tables of latitudes and longitudes that we know the wide extent of the geographical knowledge of the Arabs. Their corrections from west to east extended from Cadiz to the Indus, and they restored to their true position the places in the countries watered by the Euphrates and the Tigris. It is inferable, from statements of Arab writers, that they had maps constructed upon a mathematical basis.

* See "Popular Science Monthly," vol. x., March, 1877, article "How the Earth was regarded in Old Times."

As these maps have not come down to us, it is supposed that they were rare, and were not intended for practical use, but constructed to aid the inquiries of the learned; for the Arabians pursued the study of geography mainly in its connection with astronomy, and were not, as we would understand the term, topographers, or only to a very lim-

Fig. 8.—Edrisi's Map, A. D. 1154.

ited extent. It is rather for the preservation of what was previously known that we are indebted to the Arabs; for, though they studied geography with great assiduity, they can not be said to have greatly advanced it as a science.

Leaving the Arabs and their labors for the present, we will now return to the growth of cartography in Europe. We have maps designed to represent the earth as known, or particular parts of it, from the ninth to the fifteenth century; and which, from the rude efforts in the ninth century, exhibit the widest diversity in plan and execution. Some consist of straight parallel lines drawn across a circle, with the names of countries or places arranged along the lines. In others, the position of the Mediterranean is indicated simply by the name of the sea, and the names of countries and places are grouped about it in

what was supposed to be their true position. In none of these early maps is there any attempt to give in curved lines the form of continents, or to indicate the boundaries of countries.

About the middle of the twelfth century, Roger, King of Sicily, determined to have a map of the world constructed from the best in-

FIG. 9.—ITALIAN ITINERARY, THIRTEENTH CENTURY.

formation that could then be obtained. For this purpose he sent intelligent men to various parts of the known world, to take the latitude and longitude of places, to collect itineraries, and gather every kind of information that was desirable. Fifteen years were spent in this preparatory work, and what had thus been obtained was intrusted to Edrisi, an Arabian geographer and traveler, who had been invited to the King's court, and from these materials Edrisi compiled a general map, which was engraved upon a round table, or globe of silver. In a manuscript in the National Library of Paris there are sixty-nine maps, supposed to have been copied from this silver globe, and there is a general copy of the map attached to a manuscript in the Bodleian Library at Oxford. This work of Edrisi was superior to anything that had preceded it in the middle ages. It appears to have given a new impulse to geographical inquiries, as it was compiled chiefly from the new materials that had been obtained; for Edrisi, upon examining the works of his Arabic predecessors and the work of Ptolemy, found that they had involved the general subject of geography in such doubt, uncertainty, and confusion, that in constructing his map he rejected them altogether as sources of authority. Edrisi also composed a geographical work which has survived. Wherever in it he had to refer to the fabulous and impossible things asserted by his predecessors, he generally accompanied the statement with the formula, "God only knows how this is."

To understand more clearly the rapid progress which was made in

cartography in Europe in contrast with the little that was done for its improvement by the Arabs, it will be necessary to draw attention to the difference between the nature of the empire which they established and that era of maritime enterprise and commercial activity which sprang up, and after the twelfth century developed so rapidly in the cities of the Mediterranean. The Arabs had a vast empire, the great bulk of which had no connection with the sea. A highly imaginative people, they were more attracted by speculative inquiries respecting the earth as a whole, and therefore studied it more in its connection with astronomy than by those careful, patient, and practical topographical labors which constitute such an important part of geography. What could be done by astronomical observation to show the relative position of places they did; but they knew nothing of the Atlantic.

The people of the maritime cities of the Mediterranean had a field of activity very limited when compared with the great empire of the Arabs. It was the Mediterranean. Their pursuits were maritime. They were the carriers by water of products between Asia and Europe, and therefore became, what the Arabs never were, a nautical people. To them navigation and everything that tended to its improvement were of the highest interest, and they consequently gave great attention to details. They observed closely the outlines of coasts, carefully delineated them, and, as they had an eye for form and proportion, their maps, in design and execution, greatly excelled those of the Arabs.

These cosmographers knew very well the position of places to the pole, or geographical latitude, but in making their maps they drew no parallels of latitude, and paid less attention to longitude: for the mariners for whose use these maps were intended knew nothing about figures representing degrees of latitude and longitude, and they are consequently not found upon these maps. The distances on the land or over the sea were laid down from certain fixed points in the direction of the compass, and hence these maps are covered with a network of lines running in all directions from central points, called wind-roses (*rose de vent*), which, to persons familiar only with maps of the present day, are unintelligible.

In the fifteenth century, great acquisitions were made to the knowledge of the world, especially in Asia and Africa, by the journeys of Marco Polo and Cadamosto; and the result of this accumulation of new information was the construction, in 1457, of a large map of the world, by Fra Mauro. It was painted on the wall of a convent in Venice, and was, for its time, an admirable production.

Fra Carmelite was a friar who had established a geographical school in Venice, and whose acquisitions as a geographer were, for the time, so extensive that he received from his contemporaries the title of "*the incomparable.*" He knew that the earth is a sphere—being well acquainted with Ptolemy, but did not follow Ptolemy's scientific method of so projecting the world as to give the longitude and latitude

of places. It should be stated, as explanatory of the defective construction of general maps of the world at this time, and before it, that the belief of the ancients in the globular form of the earth was far from being generally accepted. Even among cosmographers there was great uncertainty as to its real form. Columbus thought it had the shape of a pear, and in fact its spherical form was not fully admitted until Magellan's vessel, in 1521, sailed around it. In Italy, however, the belief of the ancients, both as to the form and as to the motions of the earth, was revived as early as the middle of the fifteenth century.

About forty years before the map of Fra Mauro was executed, Prince Henry of Portugal, surnamed the Navigator, began to send out those expeditions along the western coast of Africa which were the beginning of that brilliant age of maritime exploration that led to the circumnavigation of the Cape of Good Hope, the discovery of the Continent of America, and the voyage of Magellan's vessel around the world. During this period of active discovery, the limits of Africa were greatly extended to the south, a vast continent was revealed by the discovery of America, and, the knowledge of the earth being thus largely augmented, a general map of the world had to be differently arranged and represented by new methods.

The first map upon which the discoveries of Columbus appear is that of John Ruysch, in the edition of Ptolemy printed in Rome in

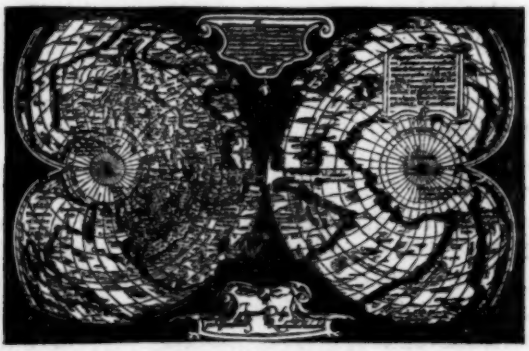

Fig. 10.—Mercator's First Map, A. D. 1538.

1508. Ruysch adopted the method of Ptolemy of projecting the earth in the form of a cone, with the Arctic at the summit, but so expanding the cone as to bring in the Western Hemisphere and show the islands and a part of the mainland discovered by Columbus and others. In 1511 Bernard Sylvanus produced in his edition of Ptolemy a general map of the world, upon what has since been called the cordiform or heart-shaped projection, which, while giving the whole of the geographical features of the earth, was, from the curve and sweep of the parallels of both latitude and longitude, better adapted than anything

that had preceded it to convey upon a plane surface a general idea of the earth's globular form. In this map the newly discovered continent of America, under the name of "The Land of the Holy Cross," was laid down more fully and accurately than in the preceding map of Ruysch. In the following year, 1512, a Polish geographer, John de Stobnicza, in an introduction to Ptolemy, published a map which I regard as of great interest, as it was, as far as I have been able to ascertain, the first attempt to project the spherical surface of the earth upon a plane. If I am right in this supposition, it was the parent of the mode now in use in all atlases of representing in a map of the world both sides of the globe upon a flat surface by two planispheres, or circular maps joined together, one of which includes Europe, Asia, and Africa, and the other America, North and South. This map was constructed to represent that half of the globe which was unknown to Ptolemy, or substantially what is now known in maps of the world as the Western Hemisphere.

The main object of this interesting map was to show where this newly discovered land was situated, and place it in its true position with respect to the whole globe. The map is but a partial or subspherical projection, being cut off at the seventieth degree north latitude, and at the fortieth degree south latitude. The Continent of America, North and South, is represented as running northwesterly to the center of the map, and as extending from 70° north latitude to 40° south latitude, the shape of the continent as then understood being evidently derived from a chart, not then published, which, from an inscription upon it, is supposed either to have been drawn by Columbus, or under his direction. The breadth and general shape of South America, though rudely given, are remarkably correct. The isthmus separating South from North America is laid down, but exaggerated in length; and a small portion of North America is given, its extension to the west being left undefined. The position which the whole continent occupies as a part of the globe is, as would be expected, not correctly laid down, but, as a conjectural representation of its exact position, the map was for that time (A. D. 1512) a very remarkable production.

I have dwelt upon this map, because it has not received from geographers the attention it deserves; and for the further reason that it furnishes a striking illustration of the slow progress of geographical knowledge; for the projection of maps of the world, upon the same scientific method, did not come into general use until about the beginning of the last century, or nearly two hundred years afterward.

In 1520 Peter Benewitz constructed a map of the world in the form of a heart, after the method of Sylvanus, which has acquired a celebrity as the first map upon which the name of *America* appears.

In 1531 Oronce Fine undertook to improve this by a projection in the form of a double heart, so as to give, by that method, upon a plane or flat surface, both sides of the globe; and in 1538 Mercator, then a

young man of twenty-eight, published a map of this double-heart projection, making many corrections, especially in respect to the Continent of America, of which only one copy is known to exist, attached to an

FIG. 11.

edition of Ptolemy of 1578, that belonged to Mercator, and which has been liberally deposited by a member of our council, J. Carson Brevoort, in the library of our society.

All these maps, in their delineation of the outline of countries, were very defective, and especially in respect to the Continent of America. The accessions to geographical knowledge had become so vast and the

details were so enormous that the work of giving the whole of the surface of the earth, as far as known, with all the details of continents, oceans, gulfs, bays, straits, rivers, mountain-ranges, and islands, with any marked approximation to correctness, was not accomplished until Mercator produced his great map of the world in 1569; which, when the fullness of its details is considered in connection with the new and scientific method upon which he projected it, entitles him to the appellation of the father of modern cartography. In this map he introduced what has ever since been known as Mercator's projection, which not only gave the world in one view, but by an ingenious and simple contrivance showed the most effectual way for a vessel to sail in a straight line over a curved surface, and thereby solved what was before one of the most difficult problems in navigation. That projection constitutes, down to the present day, the basis of every chart that is constructed to guide the mariner in his way over the ocean, and the map of the world on his projection is to be found in nearly every English or American atlas that has been published for a century and more, and yet the inquirer would search in vain in any work in the English language for the particulars of Mercator's life, or for any satisfactory account of what he did. How little is known respecting him, even by nautical men, will be sufficiently indicated when I state that, upon speaking about him not very long ago to a distinguished admiral, he looked at me and exclaimed: "What! was there such a man as Mercator? I always supposed Mercator's projection meant the merchant's projection."

ANCIENT METHODS OF FILTRATION.*

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THE separation of a liquid from solids suspended in it, by straining through some material pervious to the one and impenetrable to the other, was a familiar process in the remotest antiquity. Observation of various processes in nature, such as the purification of water by trickling through sandy soil, or perhaps the accidental passage of rain-water through an outstretched cloth, a garment, or a tent-cover, would obviously suggest the simple expedient. History fails to record the period of the invention or the name of the individual who first put it in practice. Etymological considerations show that filters were early made of fulled wool or felt; the Latin *filtrum*, "a filter," being closely connected with *feltrum*, "felt," or compressed wool, and both are related to the Greek πιλος, signifying hair.

Several writers on the history of science make casual reference to

* Read before the New York Academy of Sciences, October 13, 1879.

the operations performed by the early chemists: some state in a general way their acquaintance with the processes of distillation, sublimation, filtration, etc.; others are more explicit. Hermann Kopp, in his exhaustive "Geschichte der Chemie,"* states that "filtration as a chemical process was first accurately described by Geber, who calls it by a special name, *destillatio per filtrum*, 'trickling through a filter,' in contrast to the collection of a liquid by ordinary distillation." Ferdinand Hoefer, in his "Histoire de Chimie"† writing of Geber, mentions that he recognizes two kinds of distillation—with and without fire—the former being "per alembicum," and the latter consisting of "une simple filtration."

Now, we propose to show that the ancients carried on the operation of filtration in two ways, essentially distinct in principle and in the manner of execution, and that these methods were characterized by two different expressions which have been confounded by the authors named. Moreover, we shall establish this by quotations from writings covering a period of more than two thousand years.

In the first place, an examination of the very passage in Geber's Works, referred to by Kopp and by Hoefer, shows that the method therein described differs radically from filtration as ordinarily conducted at the present time. We quote the passage as found in the works of Geber, "the most famous Arabian Prince and Philosopher," "faithfully englished by R[ichard] R[ussell]," and printed at London in 1678. In the thirteenth chapter of the fourth part of the first book of the "Summe of Perfection," Geber treats of the three kinds of distillation: by an "Alembeck," by a "Decensory," and "by Filter." After describing in quaint language the well-known method of using the alembic and the decensory (which differs chiefly in the application of heat on the top of the apparatus), Geber writes thus of filtration: "The *Disposition* of that which is made by *Filter* is, that the *Liquor* to be *Distilled* be put into a *Stone Concha*, and the wider part of the *Filter* put into the said *Liquor*, even to the *Bottom* of the *Concha*, but the narrower part of it hang out over the *Orifice* of the said *Vessel*. And under that end of the *Filter* must be set another *Vessel* for receiving the *Distillation*. Therefore when the *Filter* begins to *Distill*, the *Water* with which it was moistened will first *Distill* off; which ceasing, the *Liquor* to be *Distilled* succeeds. Which *Liquor*, if it be not as yet serene, it must so often be put into the *Concha* again and redistilled, as until it be *Distilled* most serene."

This dates from the eighth century, and evidently describes a sort of capillary siphoning. The expressions "placing the wider part of the filter" into the liquid and allowing the "narrower part of it to hang out over" the vessel admit of no other interpretation. For convenience of distinguishing this method of filtration from that in which porous sacs are employed, we propose to name the former

* Vol. ii., p. 26. † Vol. i., p. 335.

anethisis, a word made from *ἀνά*, "upward," and *ἤθισις*, "a straining off." A study of the chemical works of the middle ages further shows that the expression "*destillatio per filtrum*" is invariably used to describe *anethisis*, while "*filtratio*" is applied to ordinary filtration. We shall give quotations proving this, but first make brief reference to early records.

The ancient Egyptians portray in the rock-cut memorials the operation of filtration in connection with the manufacture of wine. Their simple wine-press consisted of a bag in which the grapes were placed, and squeezed by means of two poles turned in contrary directions. Small colanders of bronze have been found at Thebes. Views of the interior of an Egyptian kitchen, cut in the tomb of Rameses III. at Thebes, represent siphons in use for drawing off liquids of various kinds. (Wilkinson.) The ancient Romans employed strainers and colanders (*colum*) made of a great variety of materials. Wine-strainers were made of silver and bronze; the poorer classes used linen, and, where nicety was not required, they used those made of broom or of rushes. Strictly speaking, however, percolation through colanders is not filtration, for capillary action plays no part.

It is interesting to note that the earliest mention of filtration which a brief search has disclosed refers to the method we have ventured to call *anethisis*. This occurs in Plato's "Symposium," written about four hundred years before the Christian era; the passage is as follows: "Socrates then sitting down, observed, 'It would be well, Agatho, if wisdom were a thing of such a kind as to flow from the party filled with it to the one who is less so, when they touch each other, like water in vessels running by means of a thread of wool from the fuller vessel into the emptier.'"*

Aristotle, the pupil of Plato, in his essay "De Generatione Animalia," refers to the other process in the following words: "Flesh is produced, therefore, through the veins and pores, the nutriment being deduced in the same manner as water through earthen vessels not sufficiently baked."

This passage, together with others occurring in Plato, shows that both systems of filtration were employed at that early period.

Geber, whose clear description of anethisis we have quoted, was followed by the celebrated Arabian physician, Rhazes; he uses the same expression, "destillatio per filtrum," in the following passage: "Dissolve as much [common salt] as you wish in five times as much warm soft water, and distill per filtrum and congeal [i. e., crystallize]."† Rhazes died about 930 A. D.

Among the early writers on alchemy, no one is oftener quoted than Raymund Lulli, surnamed the Enlightened Doctor (born 1235, died

* Plato's works, Burges's translation, vol. iii., p. 480 (Bohn).

† "Collect. ex Rhasi in Margarita Pretiosa Novella" of Petrus Bonus (1330), Venetia, 1546.

1315 A. D.). In his works we find the following characteristic passage: "Take, in the Name of God, great Bay Salt, as it is made out of the Sea; take a good quantity and stamp very small into a stone-morter: then take Cucurbites of Glass and pour your Salt therein: then take fair Well-water, and let your salt resolve into cleer water; being all dissolved then distil it by Filter; that is to say, hang a jag Felt or Woolen cloath in the Cucurbite; and let the other end hang in another Glass beside it, set as it were under it, that the water may drop into it that the Felt or Cloath may draw out and that shall be cleer as silver."

This unmistakable description of anethisis occurs in the first chapter of a booklet bearing the following title: "Philosophical and Chymical Experiments of the Famous Philosopher Raymund Lulli . . . . wherein is contained . . . . the admirable and perfect way of making the great Stone of the Philosophers as . . . . sometimes practised in England by Raymund Lulli in the time of King Edward the Third." London, 1657.

Thomas Aquinas, the eminent scholastic teacher of the thirteenth century, who is best known by his theological and metaphysical works, also paid some attention to scientific pursuits, possibly acquiring this taste from his learned master, Albertus Magnus. Aquinas, or the divine Thomas, as he was called by his admirers, defines distillation to be the "purification of waters falling drop by drop, and effected by placing a filter cut in the shape of an iron dart in the little dish containing the water to be distilled." *

Libavius, in his remarkable work, "Alchymia," sometimes called the first text-book of chemistry (published in 1595), devotes two entire chapters to the subjects of distillation and of filtration.† In the fourteenth chapter he describes, with much attention to detail, the manner of filtering by means of pieces of felt (*lacinia*) shaped like an ox-tongue, the broader portion of which is placed in the vessel containing the liquid to be filtered, and "the apex in the recipient, or, if the vessel has a narrower neck, in a suitable funnel." This demonstrates that the method was not resorted to on account of the want of proper funnels, and suggests that perhaps a special virtue was attributed to a liquid thus purified.

Libavius's work contains rude woodcuts illustrating different methods of procedure. For perfecting the purification a series of four vessels was used. These were placed on steps, one above another, and the liquid passed through a capillary siphon from the uppermost to the one immediately below, and thence by another siphon to the third vessel, and so on to the fourth. This series of vessels can be inclosed in a glass-covered box for filtering volatile liquids. Another woodcut represents the lower end of a capillary siphon hanging into a

* "Pretiosa Margarita Novella" of Petrus Bonus (1330), Venetia, 1546.

† "Comment. Alchymia," Part I., lib. iii., edition 1606.

funnel inserted in the neck of a flask. The method thus clearly portrayed is called *destillatio per lacinias*, and is evidently regarded as a process of distillation; ordinary filtration through porous stones and through bibulous paper is treated in another and following chapter.

Libavius makes reference to "Hippocrates's Sleeves,"* by which name were designated conical felt bags used in filtration.

Sir Robert Boyle, in his "Experiments touching the Spring of the Air," writes as follows: "Some learned mathematicians have of late ingeniously endeavored to reduce filters to siphons, but still the true cause of the ascension of water and other liquors, both in siphons and in filtration, [requires] a clearer discovery and explication."† And in another place he gives this "explication": "The parts of the filter that touch the water being swelled by the ingress of it to their pores are thereby made to lift up the water till it touch the superior parts of the filter that are almost contiguous to them; by which means, these being also wetted and swelled, raise the water to the other neighboring parts of the filter till it have reached the top of it, whence its own gravity will make it descend."‡

These passages can only apply to anethisis, which was apparently a common method of filtration in Boyle's day.

Again, to trace this process still later, Juncker, in his "Conspectus Chemiæ," published in 1730, describes seven kinds of filtration. These differ chiefly in respect to the materials used: two methods, however, are essentially distinct; the one is styled "*filtratio per chartam bibulam . . . in fundibulo vitreo*" (filtration through bibulous paper in a glass funnel), and the other is described in the words "*per segmentum panni lanei vel laciniam bombycinam vel funiculos gossypii*" (through shreds of woolen cloth, silken threads, or through little strings of cotton).

Our friend Professor S. A. Lattimore sends us another reference to this process from "The Laboratory or School of Arts, etc., compiled by G. Smith, sixth edition, London, 1799" (vol. i., p. 435); the passage is as follows:

"*To separate Water from Wine.*—Put into the cask a wick of cotton, which should soak in the wine by one end and come out of the cask at the bung-hole by the other; and every drop of water which may happen to be mixed with the wine will still out by that wick or filter."

Thus we see that, so recently as the close of the last century, anethisis was accounted a practical method of filtration.

* The origin of this curious term we have been unable to discover, nor is it of common occurrence in early writings on chemistry and pharmacy. The only explanation of the expression which we have as yet found occurs in the "*Lexicon novum Medicum Græco-Latinum*" of Stephen Blancardus, published in 1702. This author writes as follows: "*Manica Hippocratis* est sacculus laneus figura pyramidali, quo vina aromatica et medicamentosa, aliique liquores percolantur; ex '*ὑπο sub* et *κεραννυμι misceo.*"

† Boyle's Works, London, 1772, vol. i., p. 79. ‡ Idem., vol. iii., p. 233.

We have not found this method in Boerhaave (1727), nor in Lemery (1675), nor does Faraday, in his "Chemical Manipulations," make any allusion to it. As a process of purification of solutions, it seems to have been lost sight of in modern laboratory practice.

We have made trial of the method rendered noteworthy by more than two thousand years' practice, and find that, while the process is quite slow, it has certain advantages. Chief among these is the fact that, when the capillary siphon is adjusted, it requires no further attention; there is no pouring into a constantly emptying funnel, and there is no possibility of overflow. When properly arranged, the last drop of liquid passes from the upper vessel to the lower, and, except in certain cases of extreme divisibility, the filtration is perfect. The process seems particularly adapted to the purification of weak solutions, as of mineral waters, where the insoluble portion is not to be conserved. There is obviously much choice in the material of which the capillary siphon is made. We have tried cotton, wool, lamp-wick, and asbestus, and we find stout, silky wads of the latter most serviceable; it is also useful for filtering very acid and alkaline solutions.

The rapidity of filtration does not seem to be hastened by lengthening the longer arm of the siphon, and is chiefly dependent on the number of threads in the filter, and on their fineness. In one experiment, thirty-two strands of cotton yarn filtered twice as fast as sixteen strands, and only half as fast as sixty-four strands. Oil filters much slower than saline solutions, and the latter much slower than pure water.

We have used the expression "capillary siphoning" in describing anethisis, and perhaps it needs justification. The ascension of the liquid is due to capillarity, and the descent through the longer arm of the siphon is in obedience to gravity. Siphoning is dependent on atmospheric pressure, and can not be strictly applied to the present case; yet we find by experiment that, if the lower arm of the woolen threads be raised to the level of the liquid to be filtered, the action ceases, and the form of a siphon is at all events essential to the process.

The quotations from ancient authors show that they must have been quite familiar with capillary attraction, yet the first observance of this phenomenon is attributed by some authorities to Franciscus Aggiunti, physician to the Grand Duke of Tuscany, about the beginning of the seventeenth century.* (Aggiunti died 1635.)

In conclusion, the object of this paper is not to propose a return to this ancient method of filtration, the modern rapid processes being more in accordance with present needs; but we have thought it not altogether useless to call attention to a neglected process which can in certain cases be employed with advantage. Where the object of filtration is to collect the insoluble portion, it is obviously of no value; whether the process could be advantageously used on a large scale remains to be tested.

* Gehler's "Physikalisches Wörterbuch," article "Capillarität."

JOHN STUART MILL.

By ALEXANDER BAIN, LL. D.,
PROFESSOR OF LOGIC IN THE UNIVERSITY OF ABERDEEN.

VI.

CLOSELY connected both in date of composition and in subject-matter is the "Utilitarianism." I find from a letter that it was written in 1854. It was thoroughly revised in 1860, and appeared as three papers in "Fraser's Magazine" in the beginning of 1861. I am not aware that any change was made in reprinting it as a volume, notwithstanding that it had a full share of hostile criticism as it came out in "Fraser."

This short work has many volumes to answer for. The amount of attention it has received is due, in my opinion, partly to its merits, and partly to its defects. As a powerful advocacy of utility, it threw the intuitionists on the defensive; while, by a number of unguarded utterances, it gave them important strategic positions which they could not fail to occupy.

It is this last point that I shall now chiefly dwell upon. What I allude to more particularly is the theory of pleasure and pain embodied in the second chapter, or rather the string of casual expressions having reference to pleasures and pains. I have already said that I consider Mill's Hedonism weak. I do not find fault with him for not having elaborated a Hedonistic theory; that is a matter still ahead of us. My objection lies to certain loose expressions that have received an amount of notice from hostile critics out of all proportion to their bearing on his arguments for utility. I think that, having opponents at every point, his proper course was not to commit himself to any more specific definition of happiness than his case absolutely required.

It was obviously necessary that he should give some explanation of happiness; and on his principles happiness must be resolved into pleasure and the absence of pain. Here, however, he had to encounter at once the common dislike to regarding pleasure as the sole object of desire and pursuit—"a doctrine worthy only of swine," to which its holders have both in ancient and in modern times been most profusely likened. He courageously faces the difficulty by pronouncing in favor of a difference in *kind* or *quality* among pleasures; which difference he expands through two or three eloquent pages, which I believe have received more attention from critics on the other side than all the rest of the book put together. My own decided opinion is, that he ought to have resolved all the so-called nobler or higher pleasures into the one single feature of including with the agent's pleasure the pleasure of others. This is the only position that a supporter of utility can hold to. There is a superiority attaching to some pleasures that are

still exclusively self-regarding, namely, their amount as compared with the exhaustion of the nervous power; the pleasures of music and of scenery are higher than those of stimulating drugs. But the superiority that makes a distinction of *quality*, that rises clearly and effectually above the swinish level, is the superiority of the gratifications that take our fellow beings along with us; such are the pleasures of affection, of benevolence, of duty. To have met opponents upon this ground alone would have been the proper undertaking for the object Mill had in view. It surprises me that he has not ventured upon such a mode of resolving pleasures. He says, "On a question which is the best worth having of two pleasures, or which of two modes of existence is the most grateful to the feelings, *apart from its moral attributes and consequences*, the judgment of those who are qualified by knowledge of both must be admitted to be final." Apart from moral attributes and consequences, I do not see a difference of quality at all; and, when these are taken into account, the difference is sufficient to call forth any amount of admiring preference. A man's actions are noble if they arrest misery or diffuse happiness around him; they are not noble if they are not directly or indirectly altruistic; his pleasures are essentially of the swinish type.

Still rasher, I think, is his off-hand formula of a happy life,* if he meant that this was to be a stone in the building of a utilitarian philosophy. As a side-remark upon some of the important conditions of happiness, it is interesting enough, but far from being rounded or precise. It was only to be expected that this utterance should have the same fate as Paley's chapter on "Happiness," namely, to be analyzed to death, and its mangled remains exposed as a memento of the weakness of the philosophy that it is intended to support. It was clearly his business, in conducting a defense of utility, to avoid all questionable suppositions, and to be content with what everybody would allow on the matter of happiness.

His third chapter, treating of the "Ultimate Sanction of the Principle of Utility," has been much caviled at in detail, but is, I consider, a very admirable statement of the genesis of moral sentiment under all the various influences that are necessarily at work. Here occurs that fine passage on the social feelings of mankind which ought, I think, to have been the framework or setting of the whole chapter. Perhaps he should have avoided the word "sanction," so rigidly confined by Austin and the jurists to the penalty or punishment of wrong.

The real stress of the book lies in the last chapter, which is well reasoned in every way, and free from damaging admissions. Under the guise of an inquiry into the foundations of justice, he raises the

* Happiness was "not a life of rapture; but moments of such, in an existence made up of few and transitory pains, many and various pleasures, with a decided predominance of the active over the passive, and having, as the foundation of the whole, not to expect more from life than it is capable of bestowing."

question as to the source of duty or obligation, and meets the intuitionists point by point in a way that I need not particularize.

By far the best hostile criticism of the "Utilitarianism" that I am acquainted with is the posthumous volume of Professor John Grote. It will there be seen what havoc an acute, yet candid and respectful, opponent can make of his theories of happiness. Many of those strictures I consider unanswerable. Professor Grote also makes the most of Mill's somewhat exaggerated moral strain, and his affectation of holding happiness in contempt; "doing without it," if need be.

It was in 1860 that he wrote his volume on "Representative Government." The state of the Reform question, which led him to prepare his pamphlet on Reform, was the motive of the still larger undertaking, his principal contribution to a Philosophy of Politics. He says in the preface, that the chief novelty of the volume is the bringing together, in a connected form, the various political doctrines that he had at various times given expression to; but the mere fact of viewing them in connection necessarily improved their statement and bearings; and the six or eight months' additional elaboration in his fertile brain could not but infuse additional freshness into the subject.

In my estimate of Mill's genius, he was first of all a logician, and next a social philosopher or politician. The "Political Economy" and the "Representative Government" constitute his political outcome. People will differ as to his political conclusions, but certainly any man that wishes to judge of any matter within the scope of the "Representative Government" should first see what is there said upon it; and the work must long enter into the education of the higher class of politicians. The chapter on the "Criterion of a Good Form of Government" contains an exceedingly pertinent discussion of the relation between order and progress; and demonstrates that order can not be permanent without progress: a position in advance of Comte. The third chapter demolishes the fond theory entertained by many in the present day, that the best government is "absolute authority in good hands." Then comes a question that needs all the author's delicacy, tact, and resource, "Under what conditions is representative government applicable?" But his strongest point throughout is the exposition of the dangers and difficulties attending on democracy. This was one of his oldest themes in the "Westminster Review"; he has put it in every possible light, and discussed with apostolic ardor all the contrivances for withstanding the tyranny of the majority. He took up with avidity Mr. Hare's scheme of representation, and never ceased to urge it as the greatest known improvement that representative institutions are susceptible of. He dismisses second Chambers as wholly inadequate to the purpose in view, however useful otherwise. The discussions on the proper functions of the local governing bodies, on dependencies, and on federations, are all brimful of good political thinking. He passes by the subject of hereditary monarchy. Both

he and Grote were republicans in principle, but they regarded the monarchy as preferable to the exposing of the highest dignity of the state to competition. From my latest conversations with Mill, I think he coincided in the view that simple cabinet government would be the natural substitute for monarchy.

It was in 1861 that he turned his thoughts to a review of Hamilton's "Philosophy." Writing to me in November, he says, "I mean to take up Sir William Hamilton, and try if I can make an article on him for the 'Westminster.'" He chose the "Westminster" when he wanted free room for his elbow. He soon abandoned the idea of an article. In December he said: "I have now studied all Sir W. Hamilton's works pretty thoroughly, and see my way to most of what I have got to say respecting him. But I have given up the idea of doing it in anything less than a volume. The great recommendation of this project is, that it will enable me to supply what was prudently left deficient in the 'Logic,' and to do the kind of service which I am capable of to rational psychology, namely, to its 'Polemik.'"

He was interrupted for a time by the events in America. In January, 1862, he wrote his paper on the civil war in "Fraser." He expected it to give great offense, and to be the most hazardous thing for his influence that he had yet done.

After spending the summer in a tour in Greece and Asia Minor, he wrote again on the American question, in a review of Cairnes's book in the "Westminster." This done, he set to the "Hamilton," which was the chief part of his occupation for the next two years. His interruptions were the article on John Austin in the "Edinburgh," in October, 1863, the two articles on Comte in the end of 1864, and the revision of the "Political Economy."

I had a great deal of correspondence with him while he was engaged with Hamilton. He read all Hamilton's writings three times over, and all the books that he thought in any way related to the subjects treated of. Among other things, he wrote me a long criticism of Ferrier's "Institutes." "I thought Ferrier's book quite *sui generis* when I first read it, and I think so more than ever after reading it again. His system is one of pure skepticism, very skillfully clothed in dogmatic language." He was much exercised upon the whole subject of indestructibility of force. His reading of Spencer, Tyndall, and others landed him in a host of difficulties, which I did what I could to clear up. His picture of Hamilton grew darker as he went on; chiefly from the increasing sense of his inconsistencies. He often wished that he was alive to answer for himself. "I was not prepared for the degree in which this complete acquaintance lowers my estimate of the man and of his speculations. I did not expect to find them a mass of contradictions. There is scarcely a point of importance on which he does not hold conflicting theories, or profess doctrines which suppose one theory while he himself holds another. It almost goes against me

to write so complete a demolition of a brother philosopher after he is dead, not having done it while he was alive."

During my stay in London in the summer of 1864, he showed me the finished MS. of a large part of the book. I offered a variety of minor suggestions, and he completed the work for the press the same autumn.

Of the many topics comprised in the volume, I shall advert only to one or two of the principal. After following Hamilton's theories through ten chapters, he advances his own positive view of the belief in an external world. Having myself gone over the same ground, I wish to remark on what is peculiar in his treatment of the question.

I give him full credit for his uncompromising idealism, and for his varied and forcible exposition of it. In this respect he has contributed to educate the thinking public in what I regard as the truth. But in looking at his analysis in detail, while I admit he has seized the more important things, I do not exactly agree with him either as to the order of statement or as to the relative stress put upon the various elements of the object and subject distinction.

In the first place, I would remark on the omission of the quality of "Resistance," and of the muscular energies as a whole, from his delineation of the object or external world. In this particular, usage and authority are against him to begin with. The connection of an external world with the primary qualities has been so long prevalent that there must be some reason or plausibility in it. His own father and Mansel are equally emphatic in setting forth resistance as the primary fact of externality. Mill himself, however, allows no place for resistance in his psychological theory. In a separate chapter on the "Primary Qualities of Matter," he deals with extension and resistance as products of muscular sensibility, and as giving us our notions of matter, but he thinks that simple tactile sensibility mingles with resistance, and plays as great a part as the purely muscular ingredient; thus frittering away the supposed antithesis of muscular energy and passive sensibility. Now, for my own part, I incline to the usage and opinion of our predecessors in putting forward the contrast of active energy and passive feeling as an important constituent of the subject and object distinction; and, if it is to be admitted at all, I am disposed to begin with it, instead of putting it last as Mr. Spencer does, or leaving it out as Mill does. It does not give all that is implied in matter, but it gives the nucleus of the composite feeling as well as the fundamental and defining attribute.

The stress of Mill's exposition rests on the *fixity of order* in our sensations leading to a constancy of recurrence, and a belief in that constancy going the length of assuming independent existence. Although he shows a perfect mastery of his position, I do not consider that he has done entire justice to it from not carrying along with him the contrast of the objective and the subjective—the sensation and the

idea. Indeed, the exposition is too short for the theme; the reader is apt to be satisfied with the portable phrase "permanent possibility of sensation," which helps him to one vital part of the case, but does not amount to a satisfactory equivalent for an external and independent world. There would have been more help in an expression dwelling upon the "common to all," in contrast with the "special to me," to use one of Ferrier's forms of phraseology. This ground of distinction is not left unnoticed by Mill, but it is simply mentioned.

His chapter on the application to our belief in the permanent existence of mind is, I think, even more subtile than the preceding on matter. The manner of disposing of Reid's difficulty about the existence of his fellow creatures is everything that I could wish. It is when, in the concluding paragraph, he lays down as final and inexplicable the belief in memory, that I am unable to agree with him. This position of his has been much dwelt upon by the thinkers opposed to him. It makes him appear, after all, to be a transcendentalist like themselves, differing only in degree. For myself, I never could see where his difficulty lay, or what moved him to say that the belief in memory is incomprehensible or essentially irresolvable. The precise nature of belief is no doubt invested with very peculiar delicacy, but whenever it shall be cleared up it may very fairly be capable of accounting for the belief that a certain state now past as a sensation, but present as an idea, was once a sensation, and is not a mere product of thought or imagination. —(*Cf.* "The Emotions and the Will," third edition, p. 532.)

I may make a passing observation on the chapter specially devoted to Mansel's "Limits of Religious Thought." It is a considerable digression in a work devoted to Hamilton, but Mansel's book touched Mill to the quick; in private, he called it a "loathsome" book. His combined argumentative and passionate style rises to its utmost height. Mansel sarcastically described his famous climax—"to hell I will go"—as an exhibition of taste and temper. That passage was scarcely what Grote called it, a Promethean defiance of Jove, inasmuch as the fear of hell never had a place in Mill's bosom; it was the strength of his feelings coining the strongest attainable image to give them vent.*

Mill could not help adverting to Hamilton's very strong and paradoxical assertions about free-will; but, as he never elaborates a consecutive exposition of the question, I doubt the propriety of making these assertions a text for discussing it at full. Mill's chapter is either too much or too little; too much as regards his author, too little as regards the subject. The connection of punishment with free-will should be allowed only under protest; the legitimacy and the limits of punishment make a distinct inquiry. Punishment, psychologically viewed, assumes that men recoil from pain; there may be other springs of ac-

* Grote thought that the phrase was an echo of something occurring in Ben Jonson, where a military captain's implicit obedience is crowned by the illustration, "Tell him to go to hell, to hell he will go."

tion besides pain or pleasure; but, as regards such, both reward and punishment are irrelevant. I think Mill very successful in illustrating the independence of moral good and evil on the question of the will. He is not too strong in his remonstrance against Hamilton's attempt to frighten people into free-will by declaring that the existence of the Creator hangs upon it. It was quite in Hamilton's way to destroy all the other arguments in favor of a doctrine that he espoused, in order to give freer course to his own. He damages the advocacy of free-will by his slashing antinomy of the two contrary doctrines. It is certainly a clearing of the ground, if nothing more, to affirm, as he does so strongly, that "a determination by motives can not escape from necessitation." Such admissions give an opponent some advantage, but only as respects him individually. The general controversy, however, must proceed on different lines from his, and hence the waste of strength in following his lead.

Hamilton's attack on the study of mathematics was a battery of learned quotations brought out to confound Whewell and Cambridge. It is not very convincing; it hardly even does what Mill thinks toleration of hostile criticism tends to do, namely, bring out the half-truth neglected by the other side. It was not worth while to write so long a chapter in reply; but Mill, partly from what he learned from Comte, and partly from his own logical studies, had a pat answer to every one of Hamilton's points. Most notable, in my view, is the paragraph about the disastrous influence of the mathematical method of Descartes in all subsequent speculation. He seems there to say that the *a priori* spirit has been chiefly kept up by the example of mathematics. Now, I freely admit that the axioms of mathematics have been the favorite illustration of intuition; but there is no certainty that, in the absence of that example, intuitionism would not have had its full swing during the last two centuries. Mill admits that the crudity of Bacon's inductive canons had an equally bad effect on English speculation; but all this shows simply that error is the parent of error.

The two subjects taken up while the "Hamilton" was still in hand —John Austin and Comte—deserve to be ranked among the best of his minor compositions. The "Austin" article took him back to his early days when he worked with Bentham and attended the lectures of Austin at University College. It does not seem to contain much originality, but it is a logical treat. The two "Comte" articles are still more valuable, as being Mill's contribution to the elucidation of Comte's philosophy. It will be long ere an equally searching and dispassionate estimate of Comte be given to the world; indeed, no one can again combine the same qualifications for the work.

IMPERFECTIONS OF MODERN HARMONY.

By S. AUSTEN PEARCE, Mus. D., Oxon.

THE works of Helmholtz, and those of his English translator Ellis, have drawn attention to the fact that piano-fortes and instruments with similar key-boards are out of tune. The recent contribution to musical literature by Professor Pole having referred to the subject of intonation, it becomes a duty to the public to point out the misconceptions of these theorists, and to state that musical problems are far more complex than they believe.

Although professing to work scientifically, they allow their senses to deceive them. Professor Helmholtz in his elaborate work "On the Sensations of Tone as a Physiological Basis for the Theory of Music," says, for instance, "We often hear four musical amateurs, who have practiced much together, singing quartets in perfectly just intonation." He is deceived in this. It is a popular error that music for stringed instruments or for voices is or can be rendered in tune; and scientists writing upon the subject invariably cling to this fallacy.

An unaccompanied quartet of singers returning at the close to the exact pitch at which they began would thus most certainly prove that they had sung out of tune. This is a startling fact—stranger than the current fiction—and demands complete demonstration. The subject is abstruse, and difficult to present clearly to persons not practically acquainted with the points at issue, but for the benefit of all thoughtful readers the attempt is made.

All the great Oriental nations of antiquity were familiar with the difficulties to be overcome in establishing a tonal system. The results of their experiments are known to the musical historian. It is sufficient to say that the necessity of accurate definition was universally desired in the earliest ages of which we have any record by peoples who did not employ harmony. But our own use of chords makes questions of intonation much more intricate. We not only require a song or melody, but several songs or melodies to be given simultaneously, as in the ordinary church quartet or fugal chorus, where each singer demands the right to be provided with some important subject-matter, worthy the delivery of a feeling, acting, willing spirit—some "part" which fully occupies him. He will not be content with a mere accompaniment to some leading part. The harmonizing of these several melodies, that they may at every instant make recognized and well-proportioned combinations called chords, constitutes the modern science of harmony. This science is based upon the comparatively recent discoveries that Nature herself supplies a full chord, or *cortége* of harmonic sounds, to attend every single note, and others also to attend a union of two notes, and so on. The ancient Greeks, not being acquaint-

ed with these natural products, and misapplying certain mathematical laws, failed to obtain concords sufficiently true to satisfy their refined artistic perceptions, and therefore rejected them. The modern pagan nations, even those competent to produce perfect concords, refuse to adopt them; and therefore our modern harmony still remains either unknown or unappreciated outside Christendom. It may be that we are generally regarded in the East as Western barbarians. The Chinese, for instance, smile at the piano-forte as an ingeniously contrived arrangement for enabling the performer to produce many different sounds at once as required by Western harmony; but as a mere mechanical instrument, in which hammers are thrown against strings in an inartistic manner, illustrative of our insensibility. They formulate thirty-three ways of plucking a string with the finger, and therefore are more fastidious than ourselves respecting "touch" and the corresponding delicate variations of tone due to different modes of vibration.

It is quite evident that Eastern peoples have cultivated their perceptions in departments of musical art of which we are comparatively regardless, and it is fair to assume that they reject our harmony because of its inherent imperfections. The extremely sensitive ear of the ancient Hindoos, observed by all students of Sanskrit poetry, led them to make, in common with the Persians and modern Arabians, finer distinctions than we recognize in the musical scale. And it is certainly true that even our natural perceptions of perfect consonance are rendered less acute by habitually listening to and accepting as true harmonies that are systematically rendered untrue, and so far rough and discordant in conformity with our adopted scheme of slight deviations from strict accuracy.

Helmholtz directs us to remain satisfied no longer with this condition of things, and demands that our music be rendered in tune. Those writers who follow the lead of this great physicist take up this cry in common with others, and assume to teach musicians their art. Instrumentalists are advised to construct instruments having twenty-four, twenty-eight, thirty, forty, or more sounds within the octave, instead of allowing the ordinary twelve—the seven white and five black keys of the manual—to do duty for the whole. It is deliberately proposed that three rows of keys be provided, that a simple hymn-tune may be correctly rendered. Mr. Ellis thinks that a fourth or fifth organ or harmonium should be at hand to be used for exceptionally brilliant and novel combinations. Similar recommendations have often been made before. They are useless. For such instruments would be found too complicated for general artistic purposes, and yet would not be elaborate enough to obtain the desired perfection, because this is unattainable. It is unattainable, not on account of the incapacity of the musician, but from the nature of the case. It is impossible to unite melody and modern harmony, and retain for either its just proportions; nor can we set one or the other aside. No such

sweeping change can be made in the art by the mere musician. He can not compose music worthy the attention of the world, under the direction of any theorist, interested only in some one principle of truth; nor can he greatly alter the character of his productions.

The composer is the child of his time and nation, and can not free himself from the conditions under which he works. Yet he obeys a blind necessity no more than other men, equally powerless to turn back the tide of modern civilization. It proceeds by virtue of a force which is incontrollable, and at most can only be slightly diverted. Music is one of its art-products. It broke in upon the darkness of mediæval ages, and was a factor in the general illumination that dispelled the gloom, when the Western world arose refreshed as from a deep sleep. It appealed to the sense of hearing—the last to sink to rest, always the first to awaken.

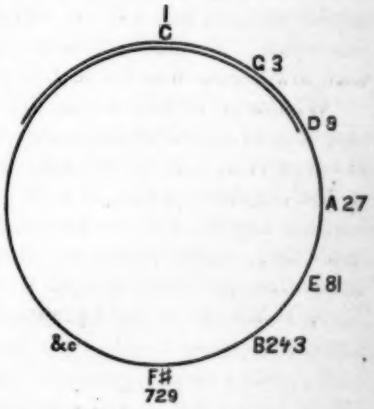
Counterpoint and the science of harmony aided in the formation of this new art, which has earned the distinction of being recognized as the only classic art of the nineteenth century. It is a glorious fabric, and will endure, although scientific purists wish it to be destroyed and another one erected in its stead on the principles of abstract truth. They propound a destructive theory, and yet give no practicable mode of procedure. They do not even remove difficulties to be overcome at the very outset. The musician is invited to attempt the impossible, namely, to make equal things that are unequal—to make the melodic scale agree with the harmonic scale, their proportions being dissimilar. He is compelled to make compromises, either acknowledged and defined, as in the systems of tuning piano-fortes, or unacknowledged and undefined, as in performances on violins. In no other manner can he proceed.

It would be easy for him to employ a few simple chords with the most perfect proportions, but he is required to produce a long-extended and complicated web of harmony—some thousands of combinations in a symphony or other similar work of art. It would be still easier for him to present chords singly as isolated columns, that they may be contemplated "as they stand"—each resting on a fundamental base or bass; but he must exhibit them connectedly—"as they move." Only by passing on and on, from chord to chord in ever-changing forms, from sweetest consonance to most brilliant dissonance, from exciting successions and combinations to calming ones, is harmonic texture provided for musical compositions. Sometimes, also, the melody remains unchanged when the harmonies are greatly altered, so that its expression may be varied, as the features of the same countenance may express varied emotions, and yet be always recognized.

Similarly, architectural purists, previous to the year 1837, made perfectly cylindrical columns, straight lines, and plane surfaces, and, proceeding to build on these principles of truth, made imitations of Greek art that are regarded with indifference in London, Paris, and Ber-

lin. The Parthenon and Theseum were to be contemplated as wholes, and therefore all apparently straight lines and plane surfaces were made respectively curved and convex, that the effect might be smoother —less hard and dry. There are, however, these notable differences in the two cases: It was possible for the architectural purist to make line meet line, but for the musician it would prove impossible. For he, working in a tonal system that is a slowly ascending infinite spiral, can not make his lines return into themselves without making delicate modifications.

Whichever way he proceeds he is led out into infinity;* but, without passing the fourth step, he is compelled to make modifications to reconcile melody with harmony. And whereas the Greek architects made slight variations from abstract truth that the effect on the beholder might be heightened, knowing well the peculiarities of the human eye, the musician trusts in the inability of the ear to detect the modifications he is bound to make, and which he hides with subtile devices.



Five modes of proceeding are now to be exemplified to prove that it is impossible to observe just proportions, and that the course taken by musicians is the best known:

1. The errors may be acknowledged and defined, by the employment of some one fixed "temperament," to determine the nature and extent of the deviations. Whether this be Pythagorean or Helmholtzian, cyclic or non-cyclic, skhismo-cyclic or mesotonic, equal or unequal, it will have as a matter of course its own peculiar inherent imperfections. The "equal" temperament is the one universally employed now for piano-fortes and organs.

2. The errors may be unacknowledged and undefined. In such cases all is left to chance or vague feeling, and the performance may be an ignorant floundering in an open sea of tone, rather than the mathematically accurate rendering as supposed by Helmholtz in the quotation given above. It is true that performers who have practiced long together, who sympathize with one another and with the aims of the composer, and who are deeply imbued with the spirit of his work, give artistically good renderings. The soul-state recorded by the composer is impressed upon the auditors. This is the purport of the music, and nothing more seems desired. It transcends all formal, cold measure-

* See article on "The Modern Piano-forte" in "Popular Science Monthly" for October, 1877, p. 701.

ments. If the performers tried to be true to these, the gist of the story, as it were, would be lost in the telling. The performance, therefore, may be psychologically true and yet mathematically false. There is a natural tendency to raise notes under the influence of extremely excited, passionate phrases and to depress them in sinking to a state of repose. But, irrespective of such changes, errors must certainly be made by singers and violinists of the nature of those now to be defined, however they may be glossed over and hidden.

Mr. Ellis illustrates his system of "Duodenes" by the first line of the hymn "My country, 'tis of thee," which is better known to German and Anglo-Saxon peoples as "God save the Queen." It will be employed here, for it is not only familiar and very simple, but usually has equally simple harmonies that may be conveniently illustrated with low numbers and a few fractions.

Whatever numbers may by chosen for convenience, the proper proportions of the melodic notes are 15 : 16 : 18. Those of the chords in columns 1, 4, 5, 6, are in the ratio of 4, 5, 6, and those in columns 2, 3 in the ratio of 10 : 12 : 15. It is understood that the doubling or halving any of these chordal numbers will merely represent the note in another octave, above or below, it will not change its character so as to affect the investigation.

3. When the melodic proportions are true, the chords are untrue.

1	2	3	4
C 48	C 48	D 54	B 45
G 36	A 40	A 40	G 36
E 30	E 30	F 32½	D 27
C 24	A 20	D 27	G 18

At the third note of the melody the chord is out of proportion, for the interval D : A, 27 : 40, should be D : A, 27 : 40½ to be in the required ratio of 2 : 3 or 10 : 15.

4. When the chords are true, the melody is temporarily out of proportion.

1	2	3	4	5	6
C 128	C′ 129⅓	D 144	B 120	C 128	D 144
G 96	A′ 108	A′ 108	G 96	G 96	G 96
E 80	E′ 81	F 86⅔	D 72	E 80	B 120
C 64	A′ 54	D 72	G 48	C 64	G 48

In this case the melody leaves the scale, but returns to it again, as shown by the notes marked (♪) which are raised. This method of altering the melody to obtain correct harmony is almost impossible to performers. It being understood that a note repeated or sustained is to be repeated or sustained at the same pitch, that it may become a pivot (ligature) for the harmonies to turn on, and form a standard of measurement. The errors would therefore more often be as follows:

5. When the chords are true, the melody is permanently out of proportion.

1	2	3	4	5	6
8 C 129⅓	24 C 129⅓	20 D 144	10 B 120	8 C 128	12 D 144
6 G 97⅓	20 A 108	15 A 108	8 G 96	6 G 96	8 G 96
5 E 81	15 E 81	12 F 86⅔	6 D 72	5 E 80	5 B 60
4 C 64⅔	10 A 54	10 D 72	4 G 48	4 C 64	4 G 48

Here the ratios of each chord are prefixed to the letters, representing the musical notes, that the harmonies may be readily verified. At the fifth chord the key-note is seen at once to be changed, and the melody therefore to be untrue. Viewed vertically, all is correct; viewed horizontally, errors appear in all four lines. Such music can not be made correct from both points of view.

No idea is more firmly rooted in the minds of musicians than that of a fixed key-note. Whenever the pitch is changed the belief is universal that the chords have been out of tune. Even Helmholtz and other scientists are unaware of the fact that perfect harmony requires a moving key-note. It will probably surprise them as much as it would have surprised Ptolemy Philadelphus to learn that the sun is moving in the direction of the constellation Hercules.

For the solar system to be, as it were, in tune, the sun must move; for the harmonic system to be in tune, the key-note must move. In the last illustration the pitch of the key-note (C) was depressed in the ratio of 129⅓ : 128. There would be three such depressions made in the first half of the melody, and by the same chords. There is no method by which the sum of the errors made in this direction may be atoned for by errors in the opposite direction. If, on repeating this half, the composer were to adopt the following harmonies, the key-note (C) would rise in the ratio of 63 : 64.

1	2	3	4	5	6
C 252	C 252	D 288	B 240	C 256	D 288
G 189	F-sharp 180	F-sharp 180	G 192	G 192	G 192
E 157½	D 144	C 126	D 144	E 160	B 120
C 126	A 108	D 144	G 96	C 128	G 96

After exploring the whole known field of harmony, and calculating the elevations and depressions consequent on using more elaborate chords, it is asserted that the exact pitch could not be regained.

The formulated results need not be stated here; it is sufficient to give the conclusions to which they point. But assuming that the composer could succeed in so planning his chords that the second half of this melody would so correct the eccentricities of the key-note in the first half that at its completion the composition would be rounded off at the true pitch, it is easy to see that if the first strain were repeated, and the second left unrepeated, or any such ordinary change made, all his elaborate calculations would be of no avail.

Mr. Ellis, who proposes a system with 117 notes within the octave, is thus shown that an infinite number of notes is required, for there is no synonymity in any system when the key-note moves. At each change of pitch the whole series is changed. Mr. Bosanquet, with 53 notes to the octave, offers to provide musicians with materials for 84 scales; and thus we are more reminded of the musical formulæ of the ancient Hindoos—their 16,000 keys—than informed how the above simple melody may be correctly rendered.

It is somewhat amusing to find Mr. Ellis seriously proposing to employ three harmoniums, the three players having to touch the notes that happen to fall to their respective instruments, not only because, as shown above, the music would still be out of tune, but because no performer would play a complete melody by himself, but a note here, another there, unconnectedly. For, however neatly this might be managed, expression or artistic rendering would be unattainable. Yet it is remarked, "The performers would merely require a little drilling and practice together."

Logarithms may be piled and compiled to define scales, but it is not so easy to reconcile the conflicting principles that appear in actual composition. The musician baffles the mathematician, who fails to follow him in his operations, as proved by the hitherto unnoticed discrepancies between melodic and harmonic proportions herein demonstrated. Although the composer's notation is not an exact statement, the performers do not experience practical difficulties: the intention is

known, and the intonation is made as perfect as may be, according to the nature of the instruments employed.

The method of tuning the piano-forte may be stigmatized as reducing music to a mere game of permutations and combinations of twelve tones, but no better method is offered by mathematicians and physicists, whose schemes for music prove them more visionary than musicians themselves, who within the limits of their art must be acknowledged to be practical. They are art-workers as a rule, not talkers. Writers on music are generally amateurs, occupied with some one principle, apparently forgetful of the fact that many principles have to be regarded in the production of an art-work—sometimes one, sometimes another having the ascendancy. Therefore, false ideas readily gain currency, for the public can more easily comprehend one or two ideas, put forth with literary skill, than a multiplicity of considerations requiring technical definition, and only correctly estimated by persons practically acquainted with their relative value. Well-written treatises on the plastic arts are frequently found suited to the use of the public, engraved illustrations being more immediately understood than musical quotations, for comparatively few persons can read, and imagine in silence, written harmonies. And, besides, the forms being original, neither geometrical nor taken from nature, no appeal to experience can be made.

Music appears as something quite apart, as though it held aloof from the realities of daily life. Yet, on closer inspection, it is seen to be connected so closely with art and life as to make its classification difficult.

Its rhythmic forms transcend any found in poetry and dancing. Its melodies are not merely grammatically correct constructions, but are felicitous expressions of the highest kind of rhetorical eloquence, which spring up as happy thoughts, and may endure from age to age with wonderful vitality as the national songs of a whole people. It is not merely dramatic, it is preëminently dramatic, many parts being employed not only consecutively but simultaneously. It simulates the gestures indicated in sculptured groups, not as fixed, but in motion, and with such ability as to create in some persons an almost irresistible desire to make corresponding movements. Its forms are original and independent of words, and are not copied like those of painting, which is still dependent on drawing.

It not only resembles Gothic architecture, in the sense of parts depending upon parts for the stability of the whole, so that a cathedral may be aptly spoken of as "petrified music"; but is more like celestial architecture, in which the base is not an immovable foundation, but moves itself; and, in the due observance of distances (intervals) and speeds (time), the balance is preserved—as, for instance, in the choruses of Bach and Handel.

Its science of acoustics allies it with optics. It can be expressed in

algebraic terms or simple numbers, as the above illustrations prove. It transfigures the spoken word in song. For its performance gymnastic exercises are required. Its expressions are like words, in being either conventional or imitative, or partly both ; and, unlike words, in that their meaning can not change. It does not describe soul-states or cause their formation after reflection, like poetry, but reveals and induces them immediately, and so surely that Beethoven's sonatas are so many psychologic records.

The composer is more bound by natural laws than other artists, and yet is so free that his productions more nearly resemble actual creations. Music, in its threefold nature, appeals to man in his threefold nature. With great splendor of manifestation an orchestra engages the ear, and sometimes powerfully affects the nervous system ; whatever is surveyable in the music occupies the intellect, and its signification affects the soul. It is not so much art-calculated as science-inspired.

Here is ample evidence that a mere "physiological basis" is insufficient for the artist, and the advice that he should form a new art, less dependent upon gorgeous harmonies, is equally futile. For, although a composer exercises greater power over music than the philologist over language (who can only explain and classify roots already existing, being powerless to provide a new one), yet still the course of music is propelled by forces that can not be long or successfully opposed. No one affects to believe that steam, electricity, etc., will be set aside at the bidding of Mr. Ruskin.

Modern compositions are the natural expression of our time. Even the music of Mozart and Haydn seems to be truly Arcadian, compared with that of Beethoven and Schumann. It is comparatively artless, cheerful, and free from sighs. The works of these later writers rise to loftier heights and sink to deeper depths, reveling in a larger scale of human passion than those of their predecessors. Here aspirations, longings, strivings, are portrayed with a vividness that mirrors the spirit of the age. This music is not, like Tennyson's "Sleeping Beauty," "a perfect form in perfect rest," but is as in a state of evolution. It wears not so much the expression of Raphael's Madonnas—of the peaceful faith of the cloister—as that of strong, earnest men, exercised with honest doubts in the battle of the creeds. We can not turn back, or remain still ; the cry is "Onward !" and, for good or for evil, we must proceed. Our art, side by side with the civilization it represents, will continue to grow, and then perhaps begin to decay, and finally give place to another still more glorious.

DAYLIGHT IN THE SCHOOLROOM.

By M. JAVAL.

WE are all agreed in preferring the light of day to any other. In spite of the extreme variations which take place in its intensity and sometimes in its coloring, we seldom think of modifying it or softening it for healthy eyes except when they are exposed to entirely unaccustomed conditions. The eye is capable of accommodating itself to most astonishing changes in the brightness of light. The light of the sun is about a million times more intense than that of the full moon; yet the eye can distinguish objects by the light of a star. The changes in the diameter of the pupil contribute only in a small degree to the faculty of adaptation, for, between the extreme dilatation and contraction of the iris, the sensitive surface does not vary in a greater proportion than that of one to a hundred. The power resides chiefly in the retina, the sensibility of which is blunted in daylight and intensified in darkness. In consequence of this remarkable aptitude, the eye is the reverse of a good photometric apparatus. Enormous changes in the intensity of light pass unperceived by it, and we are able to attend to our occupations undisturbed by the fluctuations which are constantly taking place.

Still, we must not demand of our organs the maximum of adaptation of which they are susceptible. If we read a book with the sun shining directly upon it, even if we do not injure the eyesight, we will disarrange the rate of adaptation, so that we will not be able for some time to see in a demi-obscurity. On the other hand, if we stay long in the dark, we may increase the sensibility of the retina so that a sudden return to daylight will be painful. Bearing these facts in mind, we should keep the direct rays of the sun out from workshops and schoolrooms, where the place of each person is fixed, and should not make our bedrooms too dark, lest the eye be worried by sudden changes. On a similar principle, we should flood with diffused light the rooms in which numerous workmen are to be gathered, some of whom must be far from the windows. With a good light, or one which is equivalent to several million candles a yard off, we use in reading only a fraction of the cornea, and the contraction of the pupil has the effect of greatly diminishing the diameter of the circles of diffusion which are liable to produce in the retina faults of vision. Under these conditions, a badly formed eye may perform good service, and is subject to only a moderate degree of fatigue. The brilliancy of the light may vary greatly without our losing the benefit of the clearness which an extreme contraction of the pupil assures. But as the day declines and the image on the retina becomes insufficiently luminous for clear vision, the pupil becomes dilated, and the inequalities of different eyes

are manifested. The diminution of light goes on almost unnoticed by well-formed eyes, for it is compensated by the increase of the used surface of the cornea. Less perfect eyes, on the other hand, not being able to perform their functions with ease, have to make fatiguing efforts to accommodate themselves to the situation, which tend to increase existing defects or to induce short-sightedness.

Adults are less liable than children to suffer injury from insufficient light, for several reasons: 1. Their pupils being less dilatable, they are obliged to desist from their work sooner when the light diminishes; 2. They make more frequent use of glasses; 3. They are less often confined, like school-children, and compelled to continue their labors after the light has become insufficient; and, 4. The coverings of their eyes are less extensible, and, if they have so far escaped myopia, they have more chances of continuing free from it.

A good management of the daylight is especially important with regard to the construction of schoolhouses. It is not enough to lay down a rule establishing the proportion which the surface of glass should bear to the number of pupils; attention must also be given to the direction whence the light comes to each pupil. The darkest point in the room must be light enough, and for this it is necessary that each desk shall receive a sufficiency of light direct from the sky. Every one who has practiced photography knows that the sky acts more strongly than any terrestrial body upon the sensitive surface. The least favored place in the room should be within the reach of this light. Nevertheless, the direct rays of the sun should be avoided, for they will dazzle. Where such an arrangement is otherwise practicable, the advantage of a diffused light may be gained by opening windows on the north side. Then, if the seats are placed perpendicularly to the wall occupied by the windows, so that the pupils may receive the light from the left side and from above, the result will be satisfactory provided the width of the room does not much exceed the height of the tops of the windows above the floor; for, under this condition, the least favored seat will still look upon about one twentieth of the surface of the sky. With ceilings of the ordinary height, unilateral lighting answers very well for rooms that do not exceed twelve or thirteen feet in width. For larger rooms, windows may also be opened on the other side, or behind the pupils, but never in front of them.

If we open windows in opposite sides of the room, we must arrange it so that they shall not be on the south side, for that would let in the glare of noon. For this reason it would be preferable to direct the axis of the room north and south, in which case it may be expedient to temper the forenoon and afternoon sunshine with transparent curtains. This arrangement will also give us the advantage of a better lighting in the morning and afternoon during the short days of winter. A certain latitude in orientation is admissible, which may extend to

forty degrees on either side of the north and south line, as the disposition of the ground may require. An inclination toward the north-northeast is preferable to one toward the north-northwest for general hygienic reasons, for with it the room may receive the sun for the longer time in the forenoon. The teacher should face the south, so that the pupils facing the north may receive the stronger light from behind. In the northern part of the country a window might be allowed at the top of the southern wall, to be covered during sunshine and used during dark weather.

We have still to consider the possibility of the schoolroom being shadowed by neighboring buildings. This must be prevented by acquiring enough ground to keep the buildings away. Even after we have properly proportioned the height of the windows to the size of the room, if there is a neighboring building the height of which is precisely half the distance between its base and the middle of the schoolroom, the worst situated scholars will receive the light from only the upper half of the windows, and not enough of it. We have, then, to establish the rule that a free space must be reserved on either side of the schoolroom, the width of which, measuring from the middle of the room, shall not be less than twice the height of the largest building that is likely to be put up near it. The inconvenience arising from the shade of trees is modified by the absence of leaves in the winter and their welcome presence in summer, and does not call for general rules.—*Revue Scientifique.*

HYGIENE IN THE HIGHER EDUCATION OF WOMEN.

By A. HUGHES BENNETT, M. D.

AMONG the large and increasing flocks of patients who crowd the out-door departments of our metropolitan hospitals, there is a class of persons who of late years have rendered themselves conspicuous by demanding medical assistance. These are women who have to gain their livelihood by the exertion of their intellectual faculties, and who follow callings which require the constant exercise of their mental powers. An example of this is the so-called pupil-teacher, whose career we shall endeavor briefly to sketch. A young schoolgirl of about thirteen years of age is remarked to be unusually intelligent. It is suggested to her parents that she should become a teacher. They consenting, the child is at once placed under training. According to information derived from these pupils, the routine of life for the next six or seven years is as follows: They have—1. To continue their education, by receiving from others several hours of

special instruction every day, and a considerable proportion of their evenings is spent in preparing themselves for this; 2. They themselves have to teach the younger children in the school for from five to six hours daily; 3. They have to pass a Government examination at the end of each year, which entails further special private study. This course of instruction continues for five years; and, being satisfactorily concluded, the pupil becomes an assistant teacher. During the next two years she either resides in a college and there undergoes a special and systematic course of study, or, if her means preclude, she continues the system already described at school, and further prepares herself for a final examination; after which, if she acquit herself in an efficient manner, she becomes a full teacher, and as such is certified by Government.

Such a career may be said to represent the intellectual life of an ordinary student, in which there are considerable mental strain, a constant exertion to acquire and retain knowledge, anxiety as to results, and possibly worry and irritation in details. In consequence, there are diminished exercise, loss of fresh air, and generally deficient hygienic surroundings. We have said that numbers of such young women are constantly applying to the hospitals for medical assistance. They complain of physical debility, anæmia, dyspepsia, and loss of appetite; their functions are disordered and irregular, and they present the usual conditions of bodily weakness and depression. Their nervous system and mental faculties are also affected. They are irritable, nervous, depressed, and melancholic; they do not sleep at night, partially lose their memories, they suffer from violent headaches, and can not settle to work; they have all kinds of nervous and subjective pains, hysterical symptoms, and, in short, all the phenomena of nervous and mental as well as of physical exhaustion and debility. If our patients be asked the cause of these ailments, they will with one accord say that it is the hard and constant brain-work, combined with worry and perpetual anxiety.

From teachers let us turn aside for a moment to women who follow other intellectual employments. If we examine the matter we shall find, a certain number of exceptions always being allowed, that as a rule when females are subjected to severe and prolonged mental exertion, more especially if it is associated with anxiety and physical fatigue, they break down under the ordeal. How many excellent and clever women have we known who, either from necessity or from love of study, have eagerly embraced and distinguished themselves in literary, scientific, and educational pursuits! Burning the midnight oil, contending, it may be, with difficulties, harassed with doubt and anxiety, debilitated from want of rest and bodily fatigue, they struggle on, their circumstances or their enthusiasm impelling them, but at last they, like the pupil-teachers, give way and succumb from sheer exhaustion. The objects of this paper are to endeavor to explain why

this deterioration of health should so frequently take place in women when subjected to bodily and mental strain, in distinction from men, in whom, under the same circumstances, it is comparatively unusual; and, with the view of elucidating this, to discuss the physical and intellectual capacities of the sexes, and to ascertain whether, in these respects, the male and female are upon an equal footing. That these propositions may be rendered intelligible, some preliminary observations are necessary.

THE PHYSICAL CONFORMATION OF WOMAN.—It will be generally conceded that woman is physically weaker and less powerfully built than man. With few exceptions, this distinction between the sexes is universal throughout the entire animal kingdom. From the lowest to the highest species, the general structure of the male differs from that of the female in the size and strength of his bones and muscles, the form of his head, thorax, and limbs, and in the possession of special weapons of offense and defense. In the human being, although this to a certain extent is modified by circumstances, the same general law holds good. Owing to his conformation, the man is capable of performing and of enduring more physical labor and fatigue, and hence on him, from time immemorial, has fallen the share of manual toil, and of supporting and protecting the other and weaker sex. It is true we sometimes meet with—

> "Daughters of the plow, stronger than men,
> Huge women blowzed with health, and wind, and rain,
> And labor."

Such, all will admit, are exceptions, and by no means represent the standard woman.

The generative organs form a most important distinction between the sexes, and must, to a great extent, modify the habits and career of the female. In the natural course of events, many years of the most vigorous and active period of a woman's life are spent in germinating and suckling her offspring, during which time she is physically capable of little else. If she has not children, frequently recurring periodic processes take place, which, under the best circumstances, render her specially liable to derangement of her general health, and under adverse conditions she is almost certain to fall a victim. This was demonstrated in the days of slavery, when the owners, either not knowing or caring about these physiological laws, forced their women to labor continuously in the fields, in consequence of which thousands of them died of those numerous ills to which female flesh is heir. We can not here enter at length into this very important subject, but merely indicate that the whole sexual system of woman has a profound influence on her physical nature, which does not exist to the same extent in man, and, although for conventional reasons such questions are usually suppressed in public controversies on the advancement

of her sex, there can be no doubt that they should not be forgotten, having, as they do, a most important and practical influence on the subject.

From these considerations the conclusion may be drawn that woman is structurally less powerful and vigorous than man, that she is less capable of performing acts of physical exertion, of enduring fatigue and exposure, and of combating against adverse circumstances. That, moreover, the natural functions of her sex, when they do not actually incapacitate her from action, render her specially liable, under disturbing conditions, to deterioration of general health.

THE NERVOUS CONFORMATION OF WOMAN.—The whole nervous system, in common with the other structures of the body, is smaller and less voluminous in the female than in the male. Its function is characterized by comparative weakness, as evidenced by great susceptibility and instability, and also by promptness in responding to all kinds of stimuli. In women there is less nervous capacity and vigor, diminished power of control, and a greater readiness to break down under physical and mental strain. It is notorious that the conditions termed nervous and hysterical are almost entirely confined to the female sex, in which they are extremely common. Every physician at a hospital who treats out-door patients knows that for every hundred men he prescribes for he is called upon to treat at least five hundred women. On the other hand, the male wards are always full, while many of the female beds may be vacant. This simply indicates that serious disease is most common in men, while trifling nervous ailments are almost universal in women. Most women are naturally so predisposed that, when subjected to fright, grief, anxiety, pain, and other such circumstances, they feel (in addition to the direct distressing effects) various remote subjective phenomena in the form of suffocations, spasms, bodily pains, fainting, convulsions, and a general liability to violent and explosive emotional demonstrations. If the causes are permanent their effects may become so, and deteriorate the general health, and there are thousands of women who are hopeless invalids, often for life, from conditions acting on their susceptible and mobile nervous systems, which in the other sex would have produced no appreciable results. There are, of course, in this as in other things, numerous exceptions to the general rule, many women having their natures much modified and approaching the male type, and in the same way there are some men who are of a nervous and hysterical temperament. We may, then, assert as a fact that the nervous system of the average woman is more susceptible and impressionable than that of the average man, that it is in consequence more readily unhinged by mental and physical distress or fatigue, and that when thus disordered it reacts upon the system, so as to cause permanent disease.

THE INTELLECTUAL CONFORMATION OF WOMAN.—The cranium of woman is smaller than that of man. The weight of the average

female brain has been estimated at from five to six ounces less than that of the average male brain, and a general inferiority in size exists at every period of life, from the new-born infant to old age. Not only has this comparative decrease in size been determined, but it has been ascertained that the female brain is relatively smaller than that of the male, as compared to the weight of her body, and researches on this subject have shown that, while the encephalon of the female is ten per cent. less in weight than that of the male, her total bodily weight is only eight per cent. less. The brains of different races vary greatly in size, but whether it be in the most highly civilized nations, or in the lowest savages, the encephalon of the female is always comparatively and relatively smaller than that of the male. These facts show that the difference in size and weight is obviously a fundamental sexual distinction, and not one which can be explained on the hypothesis that the educational advantages enjoyed either by the individual man or by the male sex generally, operating through a long series of generations, have stimulated the growth of the brain in one sex more than in the other. All other circumstances being alike, the size of the brain appears to bear a general relation to the mental power of the individual. There are doubtless exceptions to this rule, but unquestionably the general axiom holds good in large averages; therefore, as the organ of intellect in the female is smaller and lighter than that in the male, we may fairly assume that it is less capable of such high and extended mental powers. It is justly stated that quality as well as quantity should be considered, but of this we can only judge by results, in which case it must also be conceded that women are at a disadvantage. This assumption, if it can not be anatomically demonstrated, is amply proved by facts. From the beginning of the world, as man has been characterized by his physical force as compared to woman, so has he been remarkable for his superiority of intellectual power. At every age, in every country and climate, and under every circumstance, we find that in the highest qualities of mind, of reason, judgment, genius, inventive power, capacity for acquiring and utilizing knowledge, man stands preëminent. It is true that there have been some noble and illustrious women who have proved themselves of the highest mental capacity, and who have risen to the first rank in various departments of intellectual culture, but it must be admitted that these are rare exceptions, and that even they in every particular have been enormously outnumbered and surpassed by men. It may then be reasoned that the female has hitherto not had the opportunities or education necessary to fit her to place herself on an equality with the other sex. This argument of itself proves that she has not been born with the mental force to assert her pretensions, for it can not be maintained that physical strength alone could have forced her into a secondary intellectual position. Besides, it is not so: for in literature, poetry, music, art, and in numerous other branches of study in which she has

had as many if not more opportunities of perfecting herself than man, she has rarely proved his equal and never his superior.

The intellectual powers of woman not only differ in degree from those of man but also in character. Her mind participates with her physical constitution in being endowed with great sensibility, and hence her acuteness, perception, and tact. She seizes with rapidity objects which come before her, and observes by instinct an infinity of shades of meaning in details which might escape the most observant of men. She often arrives at conclusions with great celerity and adroitness, but then her results are as frequently wrong as right. Her perception is fine and penetrating rather than extended or profound. She readily occupies herself with small impressions and details, but is arrested there, being less capable of grasping general principles. Although her mind may thus embrace a variety of particulars, it is to little practical purpose, from an intellectual point of view, as she can not fix her attention on any idea or train of ideas for any length of time, and reason out a logical conclusion. Woman dislikes and avoids that hard work which requires long and profound meditation, her character being adverse to the study of abstract science. Her thoughts wander, she becomes impatient, and her too mobile imagination is unable to rivet the attention on the dry details of a practical subject. She enters with enthusiasm and often with unnecessary vigor at first into any new project, philanthropic, educational, or otherwise, but rarely carries it steadily out to a successful termination. Her opinions are formed by her feelings rather than by the operations of reason. Her forte is that species of knowledge which requires more tact than science, more vivacity than force, more imagination than judgment. Her chief moral philosophy is directed to the study of individuals and society, and the sagacity of a woman in acquiring traits of character and penetrating true motive is what the logic of a man rarely acquires. Wise women—the so-called blue-stocking—as a rule know nothing profoundly. Their natural acuteness of perception enables them to seize a number of details and isolated particulars, they fancy they understand them thoroughly, they confound theory with fact, the real difficulties they do not surmount, they can not fix the attention long and deeply, or persevere in overcoming obstructions, and they feel no pleasure in habits of profound meditation. They therefore remain with their acquired superficial knowledge, pass rapidly from one thing to another, and there only rest in their minds certain crude and incomplete notions, with which they are quite satisfied, and of which they make the most, but which in consequence lead to false and illogical conclusions.

These observations are not for the purpose of merely lauding one sex at the expense of the other, but for a definite practical object, as will subsequently be seen. They serve to indicate that the average woman has been by nature endowed with a brain and nervous system

of inferior anatomical construction to that of man, and that in consequence her intellectual powers differ from his, both in degree and in character.

THE DISPOSITION OF WOMAN.—Voltaire has said, "le physique gouverne toujours le morale," which is strikingly illustrated by the present inquiry. In the lower animals there is a marked difference in the disposition and character of the sexes. The males are of a combative nature, and have a great tendency to fight. They are bolder, fiercer, and more untamable. The females have more highly exalted perceptive faculties, they are cautious, artful, and cunning, as is abundantly seen in the ingenious methods they adopt in the hiding and protecting of their young. These properties serve them to some extent in lieu of physical force, and they are altogether more gentle and more tractable in their nature. The same, in a different degree, is obvious in the human female. Every mother knows that a male infant is more troublesome to rear than a female. As children grow older the difference becomes more marked. The girl is less boisterous, willful, and imperious than the boy. She is more delicate, impressionable, and artful, pleased with attention, solicits admiration, and is readily moved to tears at suggestion of sorrow or pain. He courts danger, is bored with solicitude, and, more blunted or careless, laughs at what she weeps at. She, with her doll, already anticipates the gentle duties of maternity. He, with his sword and trumpet, mimics the glory of war. On the disposition of the fully-developed woman poets have written volumes. We, however, have to take a more matter-of-fact view of her than they have done. When Hamlet said, "Frailty, thy name is woman," he was scientifically correct, in more senses than he intended. Her natural muscular feebleness and delicacy of constitution render violent exercise and labor distasteful to her, and her inferiority of intellectual power makes severe and constant mental exertion a task. While the man, full of bodily and mental vigor, goes forth seeking and braving danger and labor, proud in the responsibility of those dependent on him, the woman fulfills a welcome task at home in the less active duties of matrimony, and of domestic and social observances, equally happy in the possession of a strong arm and head to protect and support her. Such an existence, however, fosters a great susceptibility of character in addition to her natural conformation. Hers is often a mixture of extreme happiness or of profound misery. She feels pain, grief, and anxiety acutely. To these she readily gives way, and as rapidly revives from their effects. Sensations of all kinds act on her powerfully. These she can not control, but exaggerates into extremes, and manifests by violent demonstrations. If she feels acutely it is not for long, her sentiments at the time being easily replaced by new ones, and her mental distress, if rapidly induced, is more poignant than deep. Woman is essentially impulsive and emotional; her sensitive and changeable nature is necessary for

the part she has to play in life. She feels more than she thinks. A man forces his way by power of body and intelligence. She acts on him by tact and by all those weaknesses in which with him lies her chief power. Her flexibility of character gives rise to caprice which consists of a brusque passage from one sentiment to another totally opposed. Her habitual feebleness and deficient vigor inspire her with less confidence; and, as a woman can not therefore act directly, she employs indirect measures to effect her ends. Hence the natural desire to please inherent in the sex, the artfulness, the dissimulations, the little managements and intrigues, the graces, the coquetry, and other seductive ways, which, to a certain extent, have always been ceded to by intellectual and physical force. For the same reasons, and from the same cause, her weaknesses and vices are greater, and no man can compete with a really bad woman in petty jealousies, spiteful actions, revenge, and even in the ingenuity and vindictiveness of crime. It is this affectability which, if it be a cause of her frailties, is equally efficacious in giving luster to her virtues. It is this which constitutes the chief charm of the mother, who instinctively detects the slightest desire or change in her offspring and impulsively acts for its benefit; of the wife, who sympathizes with and encourages her husband, fagged and anxious for the common weal; and of the nurse, who takes in at a glance all the details and wants of the patient and ministers to his requirements with pity and devotion. It is this which gives rise to that compassion, sympathy, piety, and affectionate disposition which are the chief characteristics of a woman. It is the feeling of powerlessness which makes her identify herself with the unfortunate and unhappy, which natural pity is the base of all social virtues.

The Effects of Social Life and Education on Woman.—There can be little doubt that social manners, education, and an infinity of circumstances may affect the qualities woman derives from her material organization, and even efface the original character which nature has given her. In the simplest condition, the man labors with his hands and with his wits for mutual support and protection; the woman rears her children, tends the sick, and conducts domestic affairs. Such, if the most primitive, is probably the healthiest and happiest condition for the female. Her sympathetic and susceptible nature has here every scope for action without being shaken by rude and oft-repeated shocks. In civilized life, especially among the upper classes, everything seems combined to foster and increase the natural affectability of woman's nature, and society renders her, already unfortunate by organization, the victim of the most painful and varied series of moral and corporeal affections. Medical philosophers have declaimed, and will long continue to do so, in vain, against the whole system of the education and bringing up of women, which is directed solely to the purpose of making them personally attractive, and subsequently securing for them brilliant settlements for life, at the expense of their

health. Much might be written on this subject; suffice it at present to state that the useless and insipid lives that most young ladies lead, the total want of an intelligent interest and occupation, and the unnatural and artificial existence pursued, are highly calculated to injuriously enhance that natural affectability with which she has been endowed. The system of fashionable boarding-schools, whose anxiety to render their pupils accomplished and fascinating at all costs results in a forced and at the same time imperfect training, combined with luxurious living, absence of exercise, and other healthy circumstances, tends to increase the irritability of the nervous system and to foster a precocious evolution of character. As this is increased, tone and energy are diminished. The girl returns from school a wayward, capricious, and hysterical young lady, weak and unstable in mind, habits, and pursuits. She enters into society, and there her whole mode of life further contributes to her unfortunate condition. The competitions, disappointed affection and vanity, the artificial excitements of balls, public entertainments, late hours, and all the frivolities and pleasures of fashion, tend in the same direction. The cultivation of music, poetry, novels, and other inflammatory literature nourish illusions contrary to the actual state of society. Her very dress seems made on purpose to interfere with the healthy function of her most vital organs, and to prevent the free play of muscular action essential to a sound constitution. Girls subjected to such a *régime*, when their minds and bodies should be guided in a totally opposite direction, have one order of faculties alone exercised, and these, predominating over the reasoning powers, cause a host of nervous, vaporous, hysterical, and hypochondriacal disorders. Thus women from their earliest days are constantly subjected to the yoke of prejudices, are under the necessity of a perpetual state of acting and deception, of dissembling their desires and real inclinations for the sake of propriety, of keeping to themselves the most powerful passions and the strongest propensities, and of feigning a calmness and indifference when they are devoured by a burning fire.

As to education, we have already pointed out the general unsatisfactory nature of the intellectual studies of most women. That idleness and the absence of suitable and substantial occupation for the mind which so commonly exists in the higher ranks of society are the sources of great evils no one will deny. For the frivolous and luxurious so-called duties of fashionable life, although exhausting and fatiguing, can not be said to constitute that healthy exercise of mind or body which is desirable for young women to stave off disease and maintain sound health. Study and occupation, at the same time positive, useful, and attractive, are the best correctives of an imagination ardent and disordered, of a nervous system susceptible and hypersensitive. These considerations being made patent, many women, with the impulse characteristic of their sex, have rushed to the opposite ex-

treme. They wish females to receive the same education as males, and to compete with them in the intellectual struggle for existence. We have, however, seen that both the woman's body and mind are inferior in vigor and power to those of the man, and accordingly, if pitted against one another in a physical or mental race, she, to use a sporting phrase, would be heavily handicapped. She will not, as a rule, reach his standard, and, if she endeavors to do so, it will be at the expense of her health. The brain and nervous system, like other organs, if overworked, become the centers of activity, and are fatigued; this increases existing susceptibility, and hence arise symptoms of nervousness, hysteria, hypochondriasis, and insanity. These acting on the body produce emaciation and other diseases, the offspring of an exhausted constitution.

The conclusion, then, to be drawn from this section is that, in addition to the natural affectability of her character, this condition in woman is fostered and augmented by the artificial exigencies of civilized life; that, whereas idleness and want of occupation are the greatest sources of many diseases peculiar to the sex, the opposite extreme of mental strain is equally prejudicial.

We have endeavored, in the brief space allotted us, to point out the physical and intellectual capacities of woman, and in consequence the disposition and instincts which nature has implanted in her. This fundamental difference between the sexes, we have seen, is not due to education or special cultivation, but to a primary development of the system, each having those peculiarities best fitted for the part it has been born to fulfill. There can therefore be little doubt that the most natural and healthy condition for a woman is a properly assorted marriage, in which she has children, with whom she has useful and congenial occupation, and by whom all her sympathies and best instincts are developed. In modern times great and laudable efforts are being made to effect an improvement in the higher education of women, and, as there are many who either from choice or circumstances can not occupy that position which it is the pride of most to possess, a movement has been made whereby they may earn an independent livelihood by the exercise of their mental faculties. We are informed by energetic and doubtless well-meaning speakers from the platform, that women have hitherto been under subjection, that they should emancipate themselves, that their intellect is as good as if not better than that of men, and that they are as capable as men are of the highest mental culture, and of profiting and distinguishing themselves thereby. It is unquestionable that suitable occupation and education are of the highest importance to the well-being of women, and that all due encouragement should be given to those who endeavor to provide for them an intelligent interest in life. But in avoiding Scylla care must be taken not to drift into Charybdis. To say that the majority of women are fit to cope successfully with men in the intel-

lectual world would, we believe, for the preceding reasons, be a most injurious doctrine, and lead to disastrous results. Our text, the pupil-teacher, is an example. A young girl, between the ages of fourteen and twenty-one, the most anxious and important period in her whole life, when her mental and physical constitution is undergoing development, is put under a severe intellectual strain. She is irritated and worried all day by teaching children, she is fatigued by hard study, and is rendered constantly anxious by the frequently recurring examinations on which her reputation, and it may be her living, depends. Such a career does not as a rule break down the young man, but in a large number of cases it completely unhinges the woman. She, in fact, is compelled to perform the work of a man without having his organic basis to depend on, and hence, as a consequence, her entire system suffers. So it is with women who follow other pursuits requiring severe mental application; they age before their time, and finally succumb. It is true that men occasionally give way under the same ordeal, but these are comparatively the exception, and this is as often brought about by the assistance of other circumstances as by work alone. It is also a fact that there are some women who, overcoming all difficulties, have fully acquitted themselves of the highest mental exertions without injury, thus proving themselves to be of masculine capacity. Whether for these the Church, the bar, and physic are to throw open their arms, I leave for others to decide; but that the majority of the sex would be benefited by a systematic encouragement to follow learned professions and other laborious callings, would be, we think, physiologically and practically an error.

How unmarried women who require to earn their living are to do so by the exercise of their intellectual faculties, is one of the great problems of the day; and by far too extensive a subject to discuss at present. Our aim has been to point out that in controversies on the question the medical aspect of the case is frequently lost sight of, and it is forgotten that, in the competition for life, woman is the weaker vessel, and liable to be broken when too roughly handled. Sage philosophers may speculate what ages may effect by evolution, but, taking woman as we find her, we believe that her welfare is to be consulted, not by encouraging her to take an independent position in life and by fostering a contempt for marriage, which is now the professed tendency of the strong-minded young lady, but by educating her in such a judicious and sensible manner as will make her a good wife, mother, and useful member of society, which is unfortunately not the inclination of the present age. If this were more systematically carried out, there would be fewer single women under the necessity of working for their own living; the outcry in behalf of these unappropriated blessings would be modified, and on entering the marriage state, which is the happiest as well as the healthiest condition, they would place

themselves in the position that it is intended by Nature they should occupy.

"....Seeing either sex alone
Is half itself, and in true marriage lies
Nor equal, nor unequal; each fulfills
Defect in each, and always thought in thought,
Purpose in purpose, will in will, they grow,
The single pure and perfect animal,
The two-celled heart beating with one full stroke
Life."

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ARTESIAN WELLS AND THE GREAT SAHARA.

By Lieutenant SEATON SCHROEDER, U. S. N.

OF late years public attention has been somewhat drawn to the great North African Desert. Mainly instrumental in directing thither even the eyes and ears of idle curiosity have been the two plans for flooding portions of that region. Of these plans, the French and the English, the former has assumed the more definite shape, though both are the subject of scientific and practical inquiry.

It may be questioned if there is not another means of improvement, more gradual, perhaps, but more sure and in many ways superior to the creation of an inland sea—superior in point of economy, and more widely diffused as well as more lasting benefits. Although our knowledge of the geological and historical part of the Sahara, and of its constitution, hydrography, and climate, is scarcely extended enough to prophesy confidently as to its future, yet it may be advanced that, if the desert is extending and the population decreasing, it is greatly due to the bigotry, hostility, and laziness of the Saharan tribes. The one requisite is water, whence the projects of supplying that need from the ocean. Perhaps it may be obtained otherwise, in comparatively homœopathic doses it is true, but fresh, and in such manner as to bring about grander results.

That water is not wanting in the Sahara is proved by the wells dotted along the routes of caravans. These are very shallow, and the water they afford is generally brackish and muddy, showing that they only reached parasitic sources and not the main subterranean sheets; but they are only the hurried work of passing caravans, whose sole thought was to supply the needs of the moment and reach the oases where very old wells have been found having a depth of over two hundred and fifty feet. It is a curious fact, too, well attested, that the number of wells has been greatly reduced by the Saharans filling up many of them as a means of defense against dreaded invasion.

These wells date back to the time of the first relations between the

blacks of Soodan and the various peoples of white race driven into the desert by successive invaders. Diodorus, a priest of Tarsus in the fourth century, speaking of the great oasis in the desert forty leagues from the Egyptian frontier, mentions it being irrigated, not by rivers nor by rains, but by springs that issue from the ground not spontaneously, nor in consequence of the rains sinking into the ground, but by great labor on the part of the inhabitants. Several wells alluded to by him have been cleared since 1849 by a French chemist, M. Ayme, who established alum-factories in two Egyptian oases. These old wells were fitted with a stone pear-shaped valve by which the issue could be regulated.

About the middle of the sixth century, Olympiodorus of Alexandria speaks of wells five hundred cubits deep. Arabian writers in the middle ages describe them in detail; their great historian, Ibn Khaldoun, speaking of the spouting wells of the Sahara, considers them "a miraculous fact."

The origin of these subterranean waters is now well known. The streams flowing down the southern slopes of the Atlas Mountains of Morocco, Algeria, and Tunis, and on all sides of the Tibesti, Hogar, and other Saharan mountains, quickly disappear through the sands. M. Vivien de Saint-Martin, in "Le Nord de l'Afrique dans l'antiquité," says that, "under the sandy crust through which the waters necessarily sink, layers of clay have been found everywhere at various depths underground, where sheets of water make actual rivers."

The natural question then arises as to what causes these streams; how the parched desert furnishes rivers? Rains are quite abundant on the summits of the mountains—so much so that, in winter especially, the streams attain considerable proportions. The Sahara experiences at times tremendous storms and torrents of rain that in a few moments cause violent freshets. Dr. Barth, in his "Reisen in Nord und Central Afrika," cites among others a deluge that he witnessed at Tintagoda in latitude 19°. In less than an hour after a heavy rainfall on the mountain a sheet of water was rushing by with such force as to carry away herds of cattle and uproot trees; it covered to a considerable depth the whole valley, over a mile broad. In "Les Touaregs du Nord," M. Duveyrier says: "I had occasion on the 30th of January, 1861, while at Oursel, at the foot of the Tasli Mountains, to observe the overflowing of one of the numerous torrents that descend from that mountain. The rapidity of the stream was a metre a second, and the water brought down such alluvia that afterward the Touaregs could sow cereals where before there had been no arable ground." Further on the same traveler says: "In the spring of 1862 a storm of rain falling on the southern slopes of the Ahaggar brought such quantities of water into the valleys of Idjeloudjal and Tarhit that a portion of the mountain was carried away. The action of the water was so rapid as to sweep away and destroy an entire tribe encamped at the

opening of the valleys." Also: "Up to 1856, on the left bank of the Ouadi Titersin, there had been a line of downs called Arekka-n-Bodelka so high that camels had been unable to cross them. A freshet in the Ouadi came with such force as to sweep away the entire mass composing the downs."

As M. Duveyrier says, the alluvial deposits from the Saharan torrents are often extremely fertile. At Biskra, at the time of the French occupation of that place (1844), a layer two yards in thickness of a rich loam was found on an ancient pillar of Roman construction.

The existence of subterranean sheets of water being well demonstrated, and a rude example being set by the untaught natives, it only remained to follow that example on the grander scale made possible by the advancement of science, and determine what benefits could be derived from these hidden treasures. Dr. Maurin enunciated, "Dig an artesian well in the region of sands, and the sands will become fixed by vegetation, and a forest of palms will soon stand where there had been a moving plain." And his saying is well borne out by numerous facts. In 1872 an old marabout (Mussulman devotee or saint) dug a well, planted palm-trees, and established himself at a place now called Tendouf; in less than a year it had become an important commercial center!

The first attempt at boring an artesian well on Algerian soil was in the plain of Oran, on the 7th of December, 1844. It was fruitless, although carried to a depth of 322 feet. A second attempt was made on the 14th of May, 1845, at Arzeu, and was likewise given up at 580 feet. Some time after the occupation of Biskra, a boring was made there to 270 feet: no result. It seemed a hopeless task to find living water, although it was well known that many years before the Arabs had had artesian wells.

General Desvaux, however, commanding the subdivision of Batna, kept studying assiduously to find means of fertilizing the barren regions around him. The perusal of several works by Tournel, by Berbrugger, by Prax, as well as a memoir of M. Dubocq published in 1853, convinced him that boring was destined to play an important part in the solution of the problem that so occupied him. In 1854 he chanced to be on the summit of a sand-hill near his camp, and overlooking the entire oasis of Sidi Rached. He saw that luxuriant vegetation, and turning away was confronted by the sterile waste on the other side. More than ever struck by the contrast, he sent for the sheik and questioned him, and learned that all the northern wells had become filled in with sand, that the parasite waters prevented digging any more, and that the entire population, broken-hearted, were looking forward to leaving their homes. As soon as possible he communicated with Marshal Randon, Governor-General of Algeria, and was authorized by him to commence a systematic search for water in the Sahara.

His project was then twofold: 1. To dig new wells in the Oued Rhir, give new life to the oases then beginning to yield to the invading sterility, and so win the gratitude of their population: 2. To revive the sandy steppes between that river and Biskra, open the desert to commerce as far as Ouargla or possibly Touat, so that French troops or isolated travelers could enter that region without the fear of dying of thirst.

He experienced some delay, of course, but finally in 1856 the material arrived at Tamerna, and on the 1st of May of that year the first blow was struck by Ali-Bey, the Caid of Tuggurt. The work was pushed rapidly forward, and on the 9th of June water issued in volumes. Lieutenant Rose, of the French army, describes the scene as being most affecting, comparing it to the miracle of Moses drawing water from the rock by the touch of his rod; the old skeik prostrates himself, mothers bathe their children in it, and it is blessed and named the Fountain of Peace. The issue of water was 69,725 gallons a day, temperature of 70° Fahr.

The news spread like wildfire, and the commandant of the province of Constantine was besieged with petitions from other oases to do as well by them. In eight years, 1856 to 1864, the French Government established in that vicinity (between the Ziban oases and the river Rhir) seventy-two artesian wells, of which twenty-four had been previously abandoned in course of execution by the natives. They cost altogether 290,000 francs ($55,970), had an aggregate depth of boring of 11,106 feet and a total first issue of 17,600 gallons per minute. The deepest was at Chegga, 364 feet; the least depth at which water was found was twenty feet. The ordinary depth was between 160 and 225 feet, and the average temperature 76° Fahr. The largest issue of any was 1,267 gallons a minute from that of Sidi Amran, 255 feet deep. In 1878 there were in Algeria 22,360 metres of wells, yielding 22,000 litres of water a second; their total cost was 2,350,000 francs.

The ground of the Sahara is so impregnated with various salts that the water of these wells, pure at first, becomes temporarily brackish. Analyses made by MM. Ville, Vatonne, and De Marigny show that each litre contained one to three grammes of sulphate of soda, one to two grammes sulphate of lime, besides chloride of soda, various salts of magnesium, and carbonate of lime.

A peculiarity of the wells is that tiny little fish, resembling small whitebait, are brought up in the water. They were first noticed by General Zickel in the water spouting from the well of Aïn-Tala, which is 145 feet deep. The length of these little creatures does not exceed one and a quarter inch. Their eyes are well shaped, although they emerge from regions so dark. They are malacopterygians, of the species *Cyprinodon cyanocaster*. Similar specimens have been found in some of the ancient wells of Egypt that were cleared by M. Ayme;

as these, in all probability came from the Nile, and as the sand excavated from those wells is much the same as that of the Algerian borings, it is supposed that in both cases the fish infiltrate through with the water to the subterranean sheets.

It must not be supposed that, once the wells are dug, all labor is at an end. M. Charles Grad, who visited the region in January, 1872, found that several had ceased flowing, and that the greater part had a less issue. A few, on the other hand, he found yielded a greater volume than at first. He studied the matter, as did also M. Ludovic Ville, Directeur des Mines d'Algérie. The causes of the lessening of the flow were found to be the crushing-in of the tubes, the accumulation of sand in them, and the increase in the number of the wells, which caused too great a drain on the reservoirs. The life of the wells there without repairs seems to be twenty-five years; some have been known to last eighty without being cleaned.

The lesson to be drawn from this is expressed by the old saying, "Waste not, want not." Wherever it is possible to dam up the running streams of winter and make a reservoir for the summer, it should be done, and artesian borings made where such streams are not available. Among other places, M. Grad maintained that the fertile basin of the Hodna, situated on the Algerian plateau, would be the scene of that kind of work. These dams have already been extensively built in the province of Oran.

In the Sahara, however, the absence of superficial streams renders artesian borings of paramount importance. They will be limited there not only by the underground supply, but in some places by the hostility of the nomadic tribes who oppose their immediate construction. To what extent they can be relied on to reclaim desert-land is still an open question, but at the very least they can be permanently distributed along the routes of caravans that penetrate into the southern solitude, and with palm-trees planted about them form shady resting-places. Up to 1872 one hundred and fifty thousand palms had been planted in the vicinity of the many wells dug in Algeria; in their shade, after the salty ground had been well washed by the flow of water, vegetables and grain were found to thrive. M. Ville, who has made such a special study of the water of the Sahara, announces that, as a rule, a well will water six times as many palms as it gives out litres per minute.

Not a few minds dwelt many years ago upon the possibility of establishing routes across the desert, but that was generally considered chimerical when account was taken of its dangers, known and unknown, the hostility of the races that inhabit it, the length of the marches under a burning sun, over a burning sand, relying upon occasional wells for water, and liable to utter destruction if caught in the path of one of those terrific storms. Still, having a colony on the north coast of the continent and another on the west coast, it is not to

be wondered at that the French, with their indisputable energy, should have thought of uniting them overland. More especially does it seem natural in the early days of steam navigation. Nowadays, when cargoes can be sent from Oran to Saint-Louis (Senegal) in eight to ten days for eight dollars or less a ton, there is no great reason for sending caravans there, whose best time in a straight line would be three months and a half. Among the enthusiasts on that question may be mentioned General Faidherbe, some time Governor of Senegal, who displayed a wonderful amount of energy in the matter. Others were not wanting, including several explorers; the efforts of the latter, however, were rather more in the interests of science than material benefits.

It was about the year 1850 that the attention of the Algerian Government began to be drawn to the project of facilitating communication across the desert. In 1854 the Geographical Society of Paris offered a special reward for any one who should go from one colony to the other *via* Timbuctoo. In 1858 the Algerian Historical Society made a special order of the day a study on the best route and method of reaching Soodan. Finally, in 1873, a company was formed in Algiers, with a capital of thirty thousand francs, and the rather vague name of "Company for the Encouragement of Commercial Explorations in the Sahara." The intention of this company seemed to be to form at Laghouat an entrepot for merchandise suitable to the southern tribes, and to try to draw to Algeria a part of the traffic of Morocco and Tripoli. The Algerian Historical Society had recommended somewhat similar measures in 1860, but they were not carried out—the cause of the failure being attributed to the lack of French agents outside the Algerian frontier. That indefatigible explorer M. Duveyrier, in 1862, proposed a route following the subterranean course of the Igharghar River southward, different from the four routes generally taken by caravans; the Azdjer chiefs, to whose interest it is to encourage traffic across the desert, offered to guarantee the security of the expedition, and the Algerian Government promised to render it practicable by wells. In 1867 an expedition was actually organized, but was abandoned for reasons not generally known.

Since then the project seems to have been dropped, only to be revived again under a different form. The question of a trans-Saharan railroad has been started, which should not astonish us in America who now think nothing of going from New York to San Francisco in less than a week. M. Paul de Soleillet was among the first to propose the construction of a railroad from Algiers to Timbuctoo, and thence to Saint-Louis; in 1872 he attempted to perform that journey to explore the route, but he got no farther than the oasis of Insalah, about six hundred miles south of Algiers, being stopped by the natives. It would seem that a more practicable route would be found farther east, clear of the Tademayt and Ahaggad plateaux, of which the latter at-

tains an elevation of over four thousand feet. The journeys of Barth and Vogel discovered that, at a short distance south of Tripoli, a series of terraces lead gradually to the vast plains of the desert, where there are only moderate undulations with occasional ravines and isolated masses of rock to Soodan. The southern part of the route was over plains slightly inclined southward. The greatest height observed in that region was six hundred metres.

M. Dupouchel, Ingénieur en chef des Ponts et Chaussées, went in 1877 to examine the ground west of the Ahaggad, and study the practicability of opening a railway between Algeria and the valley of the Niger of Soodan. The results of his examinations have appeared in book form, accompanied with maps and drawings. The route that he recommends commences at Algiers, and passes by Afreville, Boghari, Laghouat, and the oases of Touat, finally striking the Niger at Bamba, a short distance east of Timbuctoo. An eastern branch would descend that river to longitude 2° east, and would run from there toward the Tchad Lake. A western branch would ascend the Niger as far as Kouma, and then run to Saint-Louis. The total length of the line from Algiers to the Niger, deducting the part already constructed to Afreville, would be about 1,700 miles, of which the total cost is estimated at 400,000,000 francs (about $77,000,000). This is $15,000 less per mile than the average of all the railroads built in the United States during the year 1874, and $60,000 less per mile than the cost of the Central Pacific. President Grévy has recently been written to, and urged to appoint a commission to examine a proposal to construct that railroad.

It will readily be seen what an important element in the construction of a railway will be the power to supply water from underground as the work progresses. But there are enthusiasts who maintain that the object now to be accomplished is not simply the establishing of communication across the desert, nor the submerging of one very small portion for the benefit of another small portion, but no more nor less than the reclaiming—the fertilization—of the whole Sahara. This, indeed, sounds rash, and yet no less an authority than Gerhard Rohlfs, who has explored greater areas of Sahara than any other European, and whose journey from Tripoli to Rhadames and Fezzan won him a gold medal from the Royal Geographical Society of London, sustains the idea by saying that Nature would soon begin to assist man in the herculean undertaking. According to this traveler, three distinct zones separate the center of the desert from the neighboring lands of the Tchad Lake in the south; in the third or northernmost of these are immense forests of mimosas, where the ground is characterized by the absence of the smallest stone, and which, according to the aborigines, extend from Egypt to Timbuctoo, covering the Kordofan, the Darfoor, the Kamen, and the country of the Touaregs. Professor Rohlfs advances the theory that these forests are encroaching on the desert, and that in

time the Sahara will disappear under a vegetation of which the mimosas are the forerunner. "Thus," he adds, "while certain timorous spirits fear that the earth may some day be overpeopled, Nature is silently transforming the soil where man will in the future be able to pitch his tent. The Sahara will be covered with green trees, new lakes will be formed, and the rivers whose dry beds now fill the traveler with horror will be running streams of limpid water as abundant as that of the great streams of Europe."

Such a return to what seems pretty certain to have been the state of things ages ago would be most extraordinary without the help of man. The vast tract comprised between the sixteenth and thirtieth parallels of latitude, and extending from the Atlantic to the valley of the Nile, once fertile, became the arid waste of to-day mainly through neglect. A M. Largeau in 1874 visited the valley of the Igharghar, with the intention of branching off to Rhadames to study the commerce of that oasis and test the practicability of diverting to Algeria the caravans that come there by the central route from Soodan. He questioned the *chambas* on the causes of the drying of the great Saharan streams, and found that all agreed in saying that these dead rivers once ran full through a country more fertile than the Tell (the region north of the Atlas Mountain's crest), but could only explain it by legends more interesting than satisfactory.

M. Largeau gives the following explanation of the change: "It is known that pastoral people have always been great destroyers of forests, for they need large spaces of clear ground to feed the flocks that form their wealth and to promote security against the wild beasts that lurk in forests. Even now the Algerian Arabs are seen firing the woods to enlarge the narrow limits imposed upon them by colonization. So, although the great Saharan streams have not been explored to their sources, yet it is known that they commence on the bare plateaux that are but the skeletons of heights once wooded and fertile. All accounts of the inhabitants of these regions agree on that point. Consequent upon the destruction of the forests the periodical rains were replaced by rare and short though violent storms, the waters from which, instead of soaking in as in past ages, slip by on the rocky masses, carrying away the rich surface mold, and bring about the drying of the springs, and, as a direct consequence, of the rivers."

An admission of this theory leads the way easily and hopefully to the prophecy of Professor Rohlfs, and raises the question whether it would not be better on all accounts to let the salt waters of the Mediterranean circulate in their own proper bed and pursue the more economical work of conquering the desert by assistance from underground. Nearly all the fluvial network of the Algerian Sahara converges toward the Igharghar. Formed by the confluence of several small streams on the slopes of the Ahaggar, it flows northward, and soon sinks through the light sands and pursues its underground course

to the western part of the basin that the French contemplate inundating, bearing in that part of its course the name of Oued Rihr, or river Rihr. Into this same depression flows another subterranean stream, the Oued Djeddi, which has its sources on the plateaux of Laghouat in the west. The two streams in all probability united in past ages, and possibly even connected with the Mediterranean. However that may be, there seems little doubt that water in considerable quantities may be found by boring in the dry beds of these two streams. M. Largeau saw several wells in that of the Igharghar, only twenty-five feet deep, giving very sweet water, of a temperature of 70° Fahr.

With this in consideration, and the example of the marabout of Tendouf still in mind, it would seem possible not only to fertilize large areas of Algerian soil, but to bore our way as it were up the slopes of the Ahaggar and gradually restore the rain-causing forests of M. Largeau, which in their turn might attack the desert from the center, as Professor Rohlf's mimosas do from the south.

The lowest estimate of the cost of inundating the depressions in the Algerian Sahara being $5,790,000, we see that that sum otherwise appropriated would pay for boring 7,400 wells averaging 154 feet in depth, assuming the cost per foot to be the same as south of the Ziban oases. Allowing the issue to be only one half that of the wells near Biskra, the total flow would be 1,100,000 gallons per minute, which, according to M. Ville, would suffice for the irrigation of about 24,600,000 palms. One tenth of this labor and expense would produce great results.

So far facts and discussion alike have been limited to the region bordering upon Algeria and Tunis. This is because explorations have naturally been carried on there somewhat to the exclusion of the Tripolitan neighborhood, and not because similar causes and effects may not be found farther east. There is every reason to believe that the desolate region bordering the south shore of the Mediterranean between the tenth and twenty-fifth meridians is destined to experience an equal improvement with the western Sahara. The writer of this article, who was one of a party of officers of the United States Navy engaged in surveying along that coast in 1878, had occasion to observe in several places, notably at Zouaga near Tripoli, and along the shores of the Gulf of Sidra (Syrtis Major), hottest of the hot and driest of the dry, that water was to be had by digging but a short distance. He noticed, also, not a few oases just on the sandy horizon, that bespoke the presence of the life-giving element. An examination of the map shows many more. While this would not be very convincing proof to a skeptical mind, in the absence of organized investigation, it may at least be considered encouraging. The day is not far distant, however, when certain knowledge will confirm or disprove hazardous opinions. The various geographical societies of the world have ceased to let the matter rest, and Professor Rohlfs is even now in charge of an expedi-

tion sent out by the German African Society. Last January he was two hundred and fifty miles south of Tripoli, at the foot of the Black Mountains; recent advices show him to be at Benghazi, on the eastern shore of the Gulf of Sidra. Accounts of the expedition have not yet come to hand.

In the event of an increase in the commercial importance of Northern Africa, whether by inland seas, artesian wells, or railroads, or all three, means of transportation to and along the seaboard and thence to foreign ports will not be lacking. As early as 1857 a railway system was decided upon for Algeria, which included a shore-line, with branches inland to various points. The construction of this network is practically completed. On the 1st of January, 1879, there were three hundred and thirty miles of railroad in that colony. A line has also been started to connect Constantine with the city of Tunis, the bondholders being guaranteed six per cent. interest by the French Government. This will probably be completed in a year. In Morocco the development of roads is not great: we can not expect very much anyhow from that sultantate, as present laws forbid the exportation of cereals, for fear of a recurrence of the famine. In the province of Tripoli but little is needed now; when the time comes it will be easy work to build a railroad in so flat a country.

In the matter of ports, Algeria points with pardonable pride to Algiers, Oran, Arzeu, Philippeville, Bona, and several minor harbors that have been made secure by artificial works. The first mentioned was begun in 1530 by Bab Aroudj (*Anglicè* Barbarossa) and his Christian slaves, and finished by Christians guiding the labor of that pirate's descendants. Tunis boasts of a magnificent lake at Bizerta, close to the sea; a little dredging in the short, narrow channel leading out would transform it into an unparalleled harbor for ironclads, of which both Germany and Italy are said to be particularly well aware. In Tunis Bay a single inexpensive breakwater, built in only six fathoms depth, would afford perfect shelter. Farther south and east, Sphax roadstead only wants ships to fill it, and Surkennis only the Bey's order to welcome foreign vessels to which it is now closed. In the province of Tripoli may be mentioned Tripoli Port, Menelaus Bay in the Gulf of Bombah, Marsa Euharit, Marsa Tebruk, all good natural harbors, or needing but insignificant works to render them secure. In Egypt it is unnecessary to mention the splendid port of Alexandria.

The French are the pioneers in the northern part of the African Continent, and it would seem desirable for them to extend their sway to the eastward of Cape Roux. That, however, would cause diplomatic complications: England, Germany, and Italy would surely protest against any projects of annexation. But there is still scope for them in the desert. The nomadic tribes will hardly stop the southward course of empire when French industry and capital fan the breeze of progress.

THE ORIGIN OF THE GYPSIES.

IT has been repeated, until the remark has become accepted as a sort of truism, that the gypsies are a mysterious race, and that nothing is known of their origin. And a few years ago this was true; but within those years so much has been discovered that at present there is really no more mystery attached to the beginning of these nomads than is peculiar to many other peoples. What these discoveries or grounds of belief are we shall proceed to give briefly, our limits not permitting the detailed citation of authorities. First, then, there appears to be every reason for believing with Captain Richard Burton that the Jāts of Northwestern India furnished so large a proportion of the emigrants or exiles who, from the tenth century, went out of India westward, that there is very little risk in assuming it as an hypothesis, at least, that they formed the *Hauptstamm* of the gypsies of Europe. What other elements entered into these, with whom we are all familiar, will be considered presently. These gypsies came from India, where caste is established and callings are hereditary even among outcastes. It is not assuming too much to suppose that, as they evinced a marked aptitude for certain pursuits and an inveterate attachment to certain habits, their ancestors had in these respects resembled them for ages. These pursuits and habits were, that—

They were tinkers, smiths, and farriers.

They dealt in horses, and were naturally familiar with them.

They were without religion.

They were unscrupulous thieves.

Their women were fortune-tellers, especially by chiromancy.

They ate without scruple animals which had died a natural death, being especially fond of the pig, which, when it has thus been "butchered by God," is still regarded even by the most prosperous gypsies in England as a delicacy.

They flayed animals, carried corpses, and showed such aptness for these and similar detested callings that in several European countries they long monopolized them.

They made and sold mats, baskets, and small articles of wood.

They have shown great skill as dancers, musicians, singers, acrobats; and it is a rule almost without exception that there is hardly a traveling company of such performers, or a theatre in Europe or America, in which there is not at least one person with some Romany blood.

Their hair remains black to advanced age, and they retain it longer than do Europeans or ordinary Orientals.

They speak an Aryan tongue, which agrees in the main with that of the Jāts, but which contains words gathered from other Indian sources.

Admitting these as the peculiar pursuits of the race, the next step

should be to consider what are the principal nomadic tribes of gypsies in India and Persia, and how far their occupations agree with those of the Romany of Europe. That the Jāts probably supplied the main stock has been admitted. This was a bold race of Northwestern India which at one time had such power as to obtain important victories over the Caliphs. They were broken and dispersed in the eleventh century by Mahmoud, many thousands of them wandering to the West. They were without religion, "of the horse, horsey," and notorious thieves. In this they agree with the European gypsy. But they are not habitual eaters of *mullo bālor*, or "dead pork"; they do not devour everything like dogs. We can not ascertain that the Jāt is specially a musician, a dancer, a mat- and basket-maker, a rope-dancer, a bear-leader, or a peddler. We do not know whether they are peculiar in India among the Indians for keeping their hair unchanged to old age, as do pure-blood English gypsies. All of these things are, however, markedly characteristic of certain different kinds of wanderers or gypsies in India. From this we conclude, hypothetically, that the Jāt warriors were supplemented by other tribes; chief among these may have been the Dom.

The Doms are a race of gypsies found in Central India to the far northern frontier, where a portion of their early ancestry appear as the Domarr, and are supposed to be pre-Aryan. In "The People of India," edited by J. Forbes Watson and J. W. Kaye (India Museum, 1868), we are told that the appearance and modes of life of the Doms indicate a marked difference from those who surround them (in Behar). The Hindoos admit their claim to antiquity. Their designation in the Shastras is *sopuckh*, meaning dog-eater. They are wanderers, they make baskets and mats, and are inveterate drinkers of spirits, spending all their earnings on it. They have almost a monopoly as to burning corpses and handling all dead bodies. They eat all animals which have died a natural death, and are particularly fond of pork of this description. "Notwithstanding profligate habits, many of them attain the age of eighty or ninety; and it is not till sixty or sixty-five that their hair begins to get white." Travelers speak of them as "gypsies." The Domarr are a mountain race, nomads, shepherds, and robbers. A specimen which we have of their language would, with the exception of one word, which is probably an error of the transcriber, be intelligible to any English gypsy, and be called pure Romany. Finally, the ordinary Dom calls himself a Dom, his wife a Domni, and the being a Dom, or the collective gypsydom, Domnipana. *D* in Hindostani is found as *r* in English gypsy speech—e. g., *doi*, a wooden spoon, is known in Europe as *roi*. Now, in common Romany we have, even in London—

Rom	A gypsy.
Romni	A gypsy wife.
Romnipen	Gypsydom.

Of this word *rom* we shall have more to say. It may be observed that there are in the Indian *Dom* certain distinctly marked and degrading features, characteristic of the European gypsy, which are out of keeping with the habits of warriors, and of a daring Aryan race which withstood the Caliphs. Grubbing in filth as if by instinct, handling corpses, making baskets, eating carrion, living for drunkenness, does not agree with anything we can learn of the Jāts. Yet the European gypsies are all this, and at the same time "horsey" like the Jāts. Is it not extremely probable that during the "out-wandering" the Dom communicated his name and habits to his fellow emigrants?

The marked musical talent characteristic of the Slavonian and other European gypsies appears to link them with the Luri of Persia. These are distinctly gypsies; that is to say, they are wanderers, thieves, fortune-tellers, and minstrels. The "Shah-Nameh" of Firdusi tells us that about the year 420 A. D., Shankal, the Maharajah of India, sent to Behram Gour, a ruler of the Sassanian dynasty in Persia, ten thousand minstrels, male and female, called *Luri*. Though lands were allotted to them, with corn and cattle, they became from the beginning irreclaimable vagabonds. Of their descendants, as they now exist, Sir Henry Pottinger says ("Travels in Beloochistan and Scinde," p. 153): "They bear a marked affinity to the gypsies of Europe. They speak a dialect peculiar to themselves, have a king to each troupe, and are notorious for kidnapping and pilfering. Their principal pastimes are drinking, dancing, and music. . . . They are invariably attended by half a dozen bears and monkeys that are broke in to perform all manner of grotesque tricks. In each company there are always two or three members who profess . . . . modes of divining which procure them a ready admission into every society." This account, especially with the mention of trained bears and monkeys, identifies them with the Ricinari, or bear-leading gypsies of Syria (also called Nuri), Turkey, and Roumania. A party of these lately came to England. We have seen these Syrian Ricinari in Egypt. They are unquestionably gypsies, and it is probable that many of them accompanied the early migration of Jāts and Doms.

The Nāts or Nuts are Indian wanderers, who, as Dr. J. Forbes Watson declares, in the "The People of India," "correspond to the European gypsy tribes," and were in their origin probably identical with the Luri. They are musicians, dancers, conjurers, acrobats, fortune-tellers, blacksmiths, robbers, and dwellers in tents. They eat everything, except garlic. There are also in India the Banjari, who are spoken of by travelers as "gypsies." They are traveling merchants or peddlers. Among all of these wanderers there is a current slang of the roads, as in England. This slang extends even into Persia. Each tribe has its own, but the general name for it is *Rom*.

It has never been pointed out, however, that there is in Northern and Central India a distinct tribe, which is regarded even by the Nāts

and Doms and Jāts themselves, as peculiarly and distinctly gypsy. We have met in London with a poor Mohammedan Hindoo of Calcutta. This man had in his youth lived with these wanderers, and been, in fact, one of them. He had also, as is comman with intelligent Mohammedans, written his autobiography, embodying in it a vocabulary of the Indian gypsy language. This MS. had unfortunately been burned by his English wife, who informed us that she had done so "because she was tired of seeing a book lying about which she could not understand." With the assistance of an eminent Oriental scholar who is perfectly familiar with both Hindostani and Romany, this man was carefully examined. He declared that these were the real gypsies of India, "like English gypsies here." "People in India called them Trablūs or Syrians, a misapplied word, derived from a town in Syria, which in turn bears the Arabic name for Tripoli. But they were, as he was certain, pure Hindoos and not Syrian gypsies. They had a peculiar language, and called both this tongue and themselves *Rom*. In it bread was called manro." Manro is all over Europe the gypsy word for *bread*. In English Romany it is softened into *māro* or *morro*. Captain Burton has since informed us that *manro* is the Afghan word for bread; but this our ex-gypsy did not know. He merely said that he did not know it in any Indian dialect except that of the Rom, and that Rom was the general slang of the road, derived, as he supposed, from the Trablūs.

These are, then, the very gypsies of gypsies in India. They are thieves, fortune-tellers, and vagrants. But whether they have or had any connection with the migration to the West we can not establish. Their language and their name would seem to indicate it; but then it must be borne in mind that the word Rom, like Dom, is one of wide dissemination, Dūm being a Syrian gypsy word for the race. And the very great majority of even English gypsy words are Hindi, with an admixture of Persian, and not belonging to a slang of any kind—as in India, *churi* is a knife, *nāk* the nose, *balia* hairs, and so on, with others which would be among the first to be furnished with slang equivalents. And yet these very gypsies are *Rom*, and the wife is a *Romni*, and they use words which are not Hindoo in common with European gypsies. It is therefore not improbable that in these Trablūs, so called through popular ignorance, as they are called Tartars in Egypt and Germany, we have a portion at least of the real stock. It is to be desired that some resident in India would investigate the Trablūs.

Next to the word Rom itself, the most interesting in Romany is Zingan, or Tchenkan, which is used in twenty or thirty different forms by the people of every country, except England, to indicate the gypsy. An incredible amount of far-fetched erudition has been wasted in pursuing this philological *ignis-fatuus*. That there are leather-working and saddle-working gypsies in Persia who call themselves Zingan is a fair basis for an origin of the word; but then there

are Tchangar gypsies of Jāt affinity in the Punjaub. Wonderful it is that, in this war of words, no philologist has paid any attention to what the gypsies themselves say about it. What they do say is sufficiently interesting, as it is told in the form of a legend which is intrinsically curious and probably ancient. It is given as follows in "The People of Turkey, by a Consul's Daughter and Wife," edited by Mr. Stanley Lane Poole, London, 1878: "Although the gypsies are not persecuted in Turkey, the antipathy and disdain felt for them evinces itself in many ways, and appears to be founded upon a strange legend current in the country. This legend says that, when the gypsy nation were driven out of their country and arrived at Mekran, they constructed a wonderful machine to which a wheel was attached." From the context of this imperfectly told story, it would appear as if the gypsies could not travel farther until this wheel should revolve: "Nobody appeared to be able to turn it, till, in the midst of their vain efforts, some evil spirit presented himself under the disguise of a sage, and informed the chief, whose name was Chen, that the wheel would be made to turn only when he had married his sister Guin. The chief accepted the advice, the wheel turned round, and the name of the tribe after this incident became that of the combined names of the brother and sister, Chenguin, the appellation of all the gypsies of Turkey at the present day." The legend goes on to state that, in consequence of this unnatural marriage, the gypsies were cursed and condemned by a Mohammedan saint to wander for ever on the face of the earth. The real meaning of the myth—for myth it is—is very apparent. Chen is a Romany word, generally pronounced Chone, meaning the moon, while Guin is almost universally rendered *Gan* or *Kan*. *Kan* is given by George Borrow as meaning sun, and we have ourselves heard English gypsies call it *kan*, although *kam* is usually assumed to be right. Chen-kan means, therefore, moon-sun. And it may be remarked in this connection that the Roumanian gypsies have a wild legend stating that the sun was a youth who, having fallen in love with his own sister, was condemned as the sun to wander for ever in pursuit of her turned into the moon. A similar legend exists in Greenland and the Island of Borneo, and it was known to the old Irish. It was very natural that the gypsies, observing that the sun and moon were always apparently wandering, should have identified their own nomadic life with that of these luminaries. It may be objected, by those to whom the term "solar myth" is as a red rag, that this story, to prove anything, must first be proved itself. This will probably not be far to seek. If it can be found among any of the wanderers in India, it may well be accepted, until something better turns up, as the possible origin of the greatly disputed Zingan. It is quite as plausible as Dr. Miklosich's derivation from the Acingani—'Ατσίγανοι—"an unclean, heretical Christian sect, who dwelt in Phrygia and Lycaonia from the seventh till the eleventh century." The mention of Mekran

indicates clearly that the moon-sun story came from India before the Romany could have obtained any Greek name. And, if the Romany call themselves Jengan, or Chenkan, or Zin-gan, in the East, it is extremely unlikely that they ever received such a name from the Gorgios in Europe.—*Saturday Review.*

PREHISTORIC RECORDS.

THE caves, tombs, and gravel-drifts of the earth, which are of all objects the most uninteresting to the casual observer, have in our days become strangely eloquent. At the touch of science they have lent a voice to the dumb past. Raising the veil of antiquity, they have unrolled page after page of ancient history, written neither with pen nor pencil, but stamped on the rude implements of war or the chase, imprinted on the few threads of decaying tissue that inwrap the crumbling skeleton, engraved on the bracelet of bronze or silver that encircled the slender wrist of some prehistoric beauty, or chased on the brooch of gold that clasped the mantle of some renowned but forgotten chieftain.

So exact are the deductions to be drawn from these mute records of the past that they have been divided by Sir John Lubbock, in his "Prehistoric Times," into four well-defined ages—the drift age, the age of polished stone, the age of bronze, and the age of iron; each of these marking an advance in knowledge and civilization which amounted to a revolution in the then existing manners and customs of the world. The drift age or Paleolithic period is marked by deposits of rude stone implements; to it succeeds the Neolithic, or age of polished stone, in which the same stone implements were in use, but of a superior class, highly polished and well finished.

The wandering savage who lived by the chase and cut up his prey with the rude, unpolished flint knives of the Paleolithic age was coeval with many extinct animals which then ranged over the wide forests that in those early times covered our own country in common with many portions of the Continent. In the caves of Derbyshire and elsewhere, many of the rudely chipped knives and arrow-heads of these ancient hunters are found, the rudest occupying the lowest strata; showing that even in that remote age man had the same tendency to improve as now, and that the practice of even these rude germs of art led to a gradual perfecting of them. Some of the remains of the ancient Nimrods of that remote and, but for these stone records, unwritten age have been found in caves and sepulchral tumuli; and of all the living races of men they resemble the Esquimaux most closely. With them are found the remains of such extinct animals as the cave-

bear, the mammoth, and the woolly rhinoceros; and they appear to have been driven along with these animals toward the north, through the action of some geographical change whose magnitude we have now no means of gauging.

The Neolithic era marked the dawn of a new and higher civilization. In many parts of the country, notably at Hardham in Sussex and in Kent, many collections of polished stone implements have been found, such us stone axes and adzes, chisels, gouges, small saws, hammers, awls for boring, stone picks for turning up the soil, pestles, mortars, querns, and spindle-whorls. Needles have also been found, which imply a knowledge of the art of sewing; and cups and various other vessels of rude earthenware, which show that these old-world folks could ply the potter's craft with a considerable degree of deftness. The bones found show also that they no longer depended for a precarious subsistence altogether upon the spoils of the chase, but that they were herdsmen and fishermen as well. They possessed the horse, a small short-horned ox, two kinds of swine, goats, and horned sheep, with dogs of a large breed. In architecture they were unquestionably far behind, for their dwellings seem to have consisted of pits roofed with wattle. The remains of these ancient Neolithic builders are plentifully scattered over the country. They were all built or rather scooped out upon one plan. There was a circular shaft for an entrance, going down to a depth of from seven to eight feet, five to seven feet wide at the bottom, and narrowing to three at the top; and round this was a chamber or cluster of chambers. In these huts are found a variety of the polished stone implements mentioned above, bones of the domesticated animals, and shreds of pottery. In north Kent there is a series of vertical shafts sunk in the chalk; but these seem to have been rather flint-quarries than the homes of our Neolithic forefathers.

In the north of Scotland, modified perhaps to suit the greater inclemency of the climate, the Neolithic dwellings are somewhat different, and take the form of massive circular huts or burghs, as they are called. In these are found the same stone implements and the same bones of animals. The flint of which these stone implements are made was obtained by quarrying for the flint nodules in the chalk. Many of these mines with the mining tools still remain, with great quantities of chips and splinters; which show that the flint implements were, partially at least, manufactured on the spot where the flint was obtained.

In some instances, caves seem to have been used as dwellings by the Neolithic inhabitants of Europe; and, where not employed as a shelter for the living, they seem to have been frequently selected, when within reach, as a resting-place for the dead. In these cave-mausoleums, numerous skeletons of both sexes and of all ages are found. Where no cave was to be had, the dead, as our readers are already aware, were

buried in barrows or cairns; numerous broken implements were laid beside them; and, from the quantities of calcined bones found in some of these graves, it is believed that, in the case of a chief, human sacrifices may have been offered. From the number of these tombs and the plentiful remains of Neolithic dwellings scattered over Britain, we are led to the conclusion that our country, in common with Europe, had in those days a somewhat large and tolerably civilized population, who had flocks and herds, who practiced agriculture, and who were hunters and fishermen.

In the pile or lake dwellings of Switzerland, which are assigned to this era, many interesting discoveries have been made. Three kinds of wheat—one an Egyptian variety—have been found; also two kinds of barley, two kinds of millet, the remains of fruit such as apples and pears, peas, flax, and weeds. For their cattle and swine the lake-dwellers seem to have laid up winter fodder in the shape of acorns and beechnuts. They made cloth of their flax, and could even weave it into an ornamental pattern. From an examination of the human remains found in these curious lake-dwellings and in the sepulchral caves, the most eminent geologists are of opinion that our Neolithic ancestors were of the same race as the Basque-speaking peoples who are still to be found in the north of Spain and in the south of France.

However acquired, the possession of bronze marks an era of advancement. The dwellings of the people who used it were better, and their circumstances more comfortable, than those of the Neolithic tribes they succeeded. They had axes and sickles of bronze, gouges, chisels, hammers, and knives; and, as a natural consequence, all the products of their labor were superior and better finished. They could weave well a tough and strong fabric, and their clothes were formed of several pieces sewed together. Their cloth is almost invariably of linen—no woolen cloth belonging to this period having been found either in France or Switzerland; but in a wooden coffin discovered in 1861 at Ribe, in Jutland, the remains of a body were found inclosed in a cloak of coarse woolen cloth; a woolen cap covered the head, the lower limbs having been wrapped in woolen leggings. Under the cloak was a woolen shirt, girt round the waist by a long woolen band. A bronze dagger in a wooden sheath had been laid beside the dead hand; and in a small box were a few necessary articles for the long journey toward the spirit-land, consisting of another woolen cap, a comb, and a knife—the whole inclosed in a bull's hide. Another coffin contained the paraphernalia of an ancient belle, a brooch, a knife, a double-pointed awl, and a pair of tweezers—all of bronze, two studs, one of bronze and one of tin, and a javelin head of flint; while a third coffin, that of a baby, contained a small bronze bracelet and a bead of amber. Sir John Lubbock considers that these bodies belonged to the close of the bronze period. Bodies wrapped in woolen cloth have also been found in Britain, as at Scale House barrow near Rylston in

Yorkshire. It is, however, worthy of remark that it is only in the exceptional cases in which the body is turned into adipocere (an unctuous, waxy substance), that woolen cloth is found; in normal circumstances that fabric would disappear far more rapidly than linen.

The bronze remains found in the Rhône Valley prove that the art of metal-working, once acquired, was carried by these early races to great perfection. They were acquainted with the processes of casting, tempering, stamping, and engraving metal. With this discovery of a new art came a simultaneous improvement in the potter's craft; the rude cups of the Neolithic age disappear, and are succeeded by vessels of an endless variety of form and ornamentation, some of which are extremely beautiful. Some of the vases are inlaid with tin, others are marked with the same patterns employed to decorate the Etruscan vases of Italy; while others, found in the pile-dwellings of the Lake of Bourget, have representations of men and animals. The collections of bronze jewelry are also abundant and curious. They consist of bracelets, armlets, long hairpins with decorated heads, rings, ear-rings, girdles adorned with pendants, brooches, buttons, studs and torques for the neck. War being in these early days as common as it appears to be in more modern times, we find well-stored armories, comprising battle-axes, arrows, and clubs, lances and short swords, as also helmets and shields of thin plates of hammered bronze. Their graves resemble those of their Neolithic predecessors, with one important difference—dead bodies were burned as a rule instead of buried, the ashes, inclosed in urns, being placed in the tombs.

In the lake-dwellings of eastern Switzerland the implements found are of bone and stone; but in those of western Switzerland there are rich accumulations of bronze implements and utensils; while in the upper layers of *débris* iron begins to appear; showing how in its turn the bronze was supplanted by a metal still more universally useful, and destined to be the type of a grand era of enlightenment and progress. Almost as interesting and instructive as the lake-dwellings of Switzerland are the Danish kitchen-middens or shell-mounds, refuse-heaps which have accumulated round the tents or huts of the primitive population. Many of these have been examined; and rude flasks, sling-stones, axes, flint fragments, and the bones of various animals, have been obtained from them.

In primeval times, many animals were abundant in our own country and all over Europe, which seem gradually to have disappeared. Some of these enumerated by Sir John Lubbock are the cave-bear, the cave-hyena, the cave-lion, the mammoth, the woolly-haired rhinoceros, the hippopotamus, the musk-ox, the Irish elk, the wild-horse, the glutton, the reindeer, the auroch, and the urus or wild-ox. Simultaneously with these or with some of these were human beings, who harbored in caves, and whose skeletons are found in caverns mixed up with the bones of these animals, and with stone or bronze implements.

About these cave-men there is necessarily much less information than there is about those of the Neolithic period; comparatively few skulls have been found which were in a state that admitted of restoration; and, among these few, there are great differences.

With regard to the antiquity of man, Sir John Lubbock, after carefully examining the views of many eminent geologists, comes to the conclusion that man certainly existed in Western Europe during the period of the mammoth and the *Rhinoceros tichorhinus*, and that the presumption is that he also existed in Pliocene and even in Miocene times; but the proofs of that—the remains of the earliest representatives of our race—are to be sought, he thinks, in warm, almost in tropical climates.

From the manners and customs of modern savages much light may be thrown upon the early condition of prehistoric man. After considering the condition and progress of the Hottentots, Veddahs, Australians, South-Sea Islanders, Esquimaux, and others, Sir John Lubbock remarks that, in reading any account of the savage races at present existing in the world, "it is impossible not to admire the skill with which they use their weapons and implements, their ingenuity in hunting and fishing, and their close and accurate powers of observation." By all these qualities we may suppose prehistoric man to have been distinguished in at least an equal degree. The habits and customs of existing savages, however, while presenting many points in common with each other, present also many points of divergence, arising from independent development; and such was no doubt also the case in the most ancient times: the degrees of civilization even in the stone age would differ much.

It is evident that man when he first spread over the surface of the earth must have been in a condition represented by the lowest type of savage. Then by slow degrees, by imitation, and by the teaching of experience, the capacity of lodging and clothing himself, and of improving his simple implements, would develop and expand, until man, physically one of the weakest and most unprotected of all animals, would, to quote from our author, "by dint of that subtile force which we term mind," make himself independent of nature, careless of the inclemency of the seasons, skillful to force from the stubborn soil the food which suited him, or the ores from which to forge the weapons which gave him power; till at last, "monarch of all he surveyed," he could cope in his native coverts with the shaggy lion, and be more than a match for the fierce wild-bull, and overtake in the chase the fleet stag or bounding antelope.

The wild man, like the wild beast, is always timid, always suspicious, always on the watch; and the condition of the savage woman is still more cruel. "She shares," says Sir John Lubbock, "all the sufferings of her mate, and has also to bear his ill-humor and ill-usage. Even the possession of beauty, far from being an alleviation, is only

an aggravation of the evils of her lot, by securing for her a hard thralldom to many masters."

With growing civilization, on the other hand, come security and confidence, and that sense of justice and honor which is the best protection of the weak; and, with the increasing and ameliorating influences of science, a great improvement may still be looked for in the condition of our race. We stand perchance upon the threshold of a future, brighter than even the brightest dreams of our past; on the verge of a Utopia long deemed impossible, when the moral nature, unvitiated by an erring will, shall no longer fetter the eager soul to base aims and unworthy aspirations, but shall leave it to its free scope and native regality of birthright and action. Then to the human race, still in its vast masses so ineffably degraded, a new and more mighty civilization may unlock boundless stores of knowledge and power, and unseal fresh fountains of pure and unfailing enjoyment.—*Chambers's Journal.*

SKETCH OF BENJAMIN SILLIMAN.*

THERE is no other name so long and closely associated with the history of American science as that of Silliman. The first who made it illustrious was Benjamin Silliman, born in 1779, and educated for a lawyer, but who entered the field of science early in the century, accepting the new chair of Chemistry in Yale College in 1802. He was a pioneer in the department of geology, contributing to the formation of that science, not only by observations and explorations, but ably maintaining its claims and rights when these were strenuously resisted by an unenlightened public opinion. Professor Silliman also rendered an incomparable service to American science by founding, in 1818, the "American Journal of Science and Arts," but better known, both in Europe and America, as "Silliman's Journal." Of this periodical, he was for twenty years sole, and for eight years more the senior editor. After half a century of duty in the college he resigned his professorship, and died in 1864.

BENJAMIN SILLIMAN, JR., son of the preceding, and the subject of the following notice, was born in New Haven, December 4, 1816, and entered college in August, 1833. After graduation he was employed as assistant and teacher in the departments of Chemistry, Mineralogy, and Geology in Yale College, and in original studies and investigations in these sciences and their practical applications in the arts. He became associate editor with his father, in 1838, of the "American

* For this sketch we are indebted to the "Yale Book," published by Henry Holt & Co.

Journal of Science and Arts," until the close of the first series of fifty volumes of that journal in 1845. In 1846, with the accession of Professor James D. Dana, the management of the second series of that journal devolved upon the younger editors. In the same year he was appointed at Yale Professor of Chemistry applied to the Arts, the first appointment in the "Fourth Department of Philosophy and the Arts," then inaugurated, and which is more particularly mentioned below. His "First Principles of Chemistry" appeared in this year, of which over fifty thousand copies have been sold. He was a member of the Common Council of the city of New Haven in 1845–'49. In 1845–'46 he gave in New Orleans a course of lectures on agricultural chemistry, upon the invitation of the leading professional and commercial men of that city, and this, it is believed, was the first course of lectures on that subject given in the United States.

In 1849 he was elected to the chair of Medical Chemistry and Toxicology in the Medical Department of Louisville University, at that time in a highly prosperous condition, the duties of which he discharged for five winters. In 1854 he resigned this chair, to take up the instruction in chemistry in the Academical and Medical Departments at Yale, made vacant by the resignation of his father, the Geology and Mineralogy having been assigned to Professor Dana. This instruction was given under the appointment to the chair of "General and Applied Chemistry" (1854). He resigned his duties in the Academical Department in 1870.

In 1858 he published "First Principles of Natural Philosophy or Physics," and a second edition of the same in 1861.

Mr. Silliman visited Europe with his father in 1851, and subsequently edited his father's "Visit to Europe in 1851," 2 vols.; the work having been originally prepared for three volumes, it was cut down to two volumes, to match the author's "Visit to England, Holland, and Scotland, 1805."

He visited California in March, 1864, returning in February, 1865, and again in 1867 and 1872, being occupied with professional work in the mines and in mineralogical and geological explorations. He delivered the annual oration before the College of California in 1867, which has been published.

Mr. Silliman has for some years been much occupied as a scientific witness in the courts, having been employed in many important causes in which scientific testimony and investigation were called for. His aid has been also constantly invoked in various matters connected with the practical arts, where a knowledge of scientific principles is involved.

In addition to the works named above, he has printed many memoirs upon various scientific and practical subjects, addresses and opinions too numerous to mention, besides his original investigations recorded in the "American Journal of Science and Arts."

He was one of the fifty original members named in the act of Congress in 1863 incorporating the National Academy of Sciences, and served the Government in this capacity during the war upon some important commissions.

He is also one of the trustees of the Peabody Museum of Natural History, provided by the munificence of the late George Peabody, of London; and is a member of numerous scientific societies on both sides of the Atlantic.

In 1849 he received the honorary degree of M. D. from the University of Charleston, South Carolina.

In 1853 Mr. Silliman had charge of the chemical, mineralogical, and geological department of the Crystal Palace in New York; and also, in connection with Mr. Charles R. Goodrich, edited the "World of Science, Art, and Industry," illustrated, 500 figures, pp. 207, 4to; and in 1854, "The Progress of Science and Mechanism," 4to, pp. 258, in which the chief results of the great Exhibition were recorded.

In 1868 Professor Silliman parted with his private cabinet of minerals, of his own collecting, to Cornell University, where it is now exhibited as the "Silliman Cabinet." He has made important additions to the mineralogical collections of Yale College, and to the metallurgical cabinet of the Scientific School, the results of his various explorations. He solicited the funds by which the mineralogical cabinet of the late Baron de Lederer was added to the college collections in 1843.

In 1842 Mr. Silliman commenced to receive private pupils in analytical chemistry and mineralogy, in an apartment of the old laboratory in Yale College, which he had fitted up at his own expense for this purpose and to conduct original investigations in science. Previously to this time there had been no provision made for the instruction of advanced students in physical and chemical science either at Yale College or elsewhere in the United States, and the academical students had been instructed in chemistry almost exclusively by public lectures. From the first it was evident that there was the germ of a new development in the small beginning, which soon took form as the "Yale Scientific School," and subsequently grew into the "Sheffield Scientific School."

Among the first students who sought Professor Silliman's instruction were Mr. John P. Norton and Mr. T. Sterry Hunt, since among the most distinguished men of science in the United States. These studies were entirely outside the college curriculum. The college for some years took no cognizance of this effort, which was sustained solely as an individual enterprise. The students it brought to the university were not even recognized as such, and their names did not appear for some years in the college catalogue. But in 1846 a memoir was addressed to the corporation of Yale College, drawn up chiefly by Mr. Silliman, Jr., but adopted and ably seconded by his father, who

personally advocated it before the corporation at their session in July, 1846. This memoir contemplated the official recognition and organization of the new department of advanced science-teaching which had, unbidden by and almost unknown to them, sprung into existence. The result was the appointment of a committee and the widening of the plan to embrace advanced instruction in other subjects, at the suggestion of Mr. Woolsey. This committee reported in 1847 the plan of a "Fourth Department," devoted to philosophy and the arts, the first appointments to which had already been made in 1846—Mr. John P. Norton to agricultural chemistry and Mr. Silliman to chemistry applied to the arts. The "Yale Scientific School" as then organized commenced its operations in 1847, opening its laboratories in the old Presidential Mansion (formerly the dwelling of Dr. Day and Dr. Dwight).

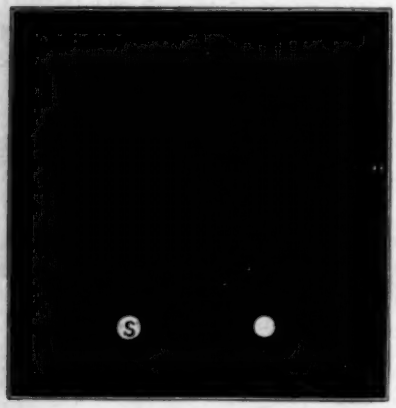
It is proper to record the fact—as showing under what difficulties and discouragements these early efforts were made—that beyond an income of three hundred dollars per annum paid for a few years by a liberal friend of the college, at the solicitation of Professor Silliman, the new department was absolutely penniless, and the entire cost of fitting and furnishing the laboratories, apparatus, libraries, and cabinets, was paid out of the private means of the two professors; who also for two years (to the shame of the corporation be it said) paid into the college treasury *a rental* for the use of the old house they had also paid for adapting and fitting for these purposes! Little encouraging as were these small beginnings, there were not wanting the zeal and enthusiasm which were better than gold, and which were reproduced in the early pupils. From its very commencement this new undertaking bore good fruit. Pupils came up in goodly numbers, and the first classes embraced names now widely known on both sides of the Atlantic. Of these, three—Brewer, Brush, and Johnson—are now professors in the Sheffield Scientific School. Out of the effort which he then commenced single-handed, and to which he devoted some of the best years of his life—always paying his own salary—has grown up a new college, embracing more professors than the old academic college had when he graduated in 1837, with two hundred students, and with constantly increasing power and endowments.

CORRESPONDENCE.

INTERESTING LUMINOUS PHENOMENON.

Messrs. Editors.

A BEAUTIFUL and unusual phenomenon was observed here on the afternoon of the 13th instant. Between three and four o'clock, the western sky being partially covered with cirri, and obscured near the horizon by a dense haze, about thirty degrees horizontally north of the sun was seen a mock-sun of dazzling brilliancy. Extending from it above and below was a luminous haze, of too small an extent and too indefinite outline at its extremities to exhibit any curvature. The entire mass of light thus appeared to have an oblate form, very much elongated vertically, the brilliant mock-sun forming its nucleus. On its sunward side the colors of the solar spectrum were plainly visible. In the clear sky, directly over the true sun, and about half-way to the zenith, was an inverted arch of pale white light, of parabolic form, with its axis to the sun, its extremities, which faded off into the blue, being five or six degrees apart. Directly overhead was an arc of a circle, of



still fainter light, whose apparent radius was about ten degrees. No prismatic tints could be detected in either of these arcs. The situation of the objects described is roughly shown in the diagram. The sky to the south of the sun was so covered by cirro-strati as to obscure any parhelion that might otherwise have been visible there. A noticeable feature of the phenomenon was the distinctly *parabolic form* of the middle arc of light. Never having seen this particular feature described in accounts of similar phenomena, I would ask if it is a usual accompaniment of them, and at the same time would ask if any satisfactory explanation of the cause of parhelia and the accompanying circles, other than the partial explanations of Huygens and Fraunhofer, has yet been given?

On the morning following the appearance described, we had light flurries of snow, and afterward rain.

G. B. SEELY.

BOSTON, *December* 15, 1879.

"THE AGE OF ICE."

Messrs. Editors.

I HAVE been placed in a false position through your publication, without date, of my article bearing the above title in your October issue of the current year. I am accused, by a paper called the "St. Louis Globe-Democrat," of plagiarizing from Croll and Merriman. Permit me to state that the article was written in 1874, nearly six years ago, and read at the session for that year of the Kansas Academy of Science, as the archives of that body will testify. I think Croll's book was not at that time published. Geikie's, if published, had not yet reached us in Kansas; and Mr. Merriman did not write till a later period. I had seen nothing on the subject but St. Pierre's "Studies of Nature," and a fugitive fragment from Adhemar. I think my manuscript was handed in too late to be printed in the "Transactions" of the Academy for that year; but doubtless the record of its presentation in 1874 is on file. I left Kansas soon after, and had seen nothing of my article from that time till the day it appeared in the "Monthly." You will testify that it was published without my knowledge.

I should have sooner adverted to the matter, only that I hoped the article would remain in the oblivion to which its slender merits entitled it; but now that I am charged with plagiarizing from men who, though vastly superior in knowledge and research, really wrote after I did, I beg space for the above, or for some editorial statement of a corresponding character.

I am yours, very respectfully,

H. B. NORTON.

SAN JOSÉ, CALIFORNIA, *December* 22, 1879.

Mr. Norton's article, referred to above, was received by us November 2, 1874, and was never afterward in the hands of the

author, nor did he know when it was to appear. The work of Mr. Croll on "Climate and Time" was published in London about six months later, or in the spring of 1875; and Mr. Merriman's articles, from which Mr. Norton is accused of borrowing, first appeared in "The Popular Science Monthly" for April and June, 1876, nearly a year and a half after the receipt of Mr. Norton's paper.—EDITORS.

EDITOR'S TABLE.

VENGEANCE IN PUNISHMENT.

THOSE dainty purists who "do not like the word *Sociology*," and are therefore hindered from taking interest in the science that passes under the name, may get a glimpse of one of its problems in unobjectionable form by reading the able paper of a practical lawyer which opens the present "Monthly." Of all the questions by which modern society is agitated, there is none more momentous than that of the public treatment of crime and criminals. No man can be found so stupid as to maintain that the present practice is satisfactory; and but few have the wisdom to indicate anything that is really much better. In this state of affairs the first thing required is to understand how present conditions were reached; and what is the nature of those changes that have brought past amelioration, and may lead on to a still better state. Only when the laws of social progress are discovered and made widely known can they be conformed to by communities with solid and lasting advantage.

We have a system of penal laws for the protection of individual rights and the conservation of society by punishing prescribed offenses; and the general notion is, that this system is coeval with government, and was originally instituted essentially in its present form and for its present purpose. This, however, is a great mistake, as is instructively shown by Mr. Billson. He points out that the first rude governments have only a concern for themselves. Government arose in tribal antagonisms, was a militant organization against external foes, and recognized no crimes except such as treason, cowardice, desertion, or such acts as injured itself. There was, at first, not the slightest idea of protecting citizens against crime by punishing private offenses. Individuals were left to redress their own grievances. Murder, for example, was a private wrong, to be privately avenged by a relative of the victim, who was at liberty to kill the murderer. Government had no internal police or judicial processes, and the rule of punishment was that of private personal vengeance. Society, as a consequence, was torn by internal feuds and bloody violence, and was ruled by the spirit of retaliation and revenge. Mr. Billson shows us the extent and atrocity and tenacity of this system, and how criminal law arose out of the necessity of regulating the excesses of malignant blood-avengement.

This chapter in the criminal history of society has a grave significance as interpreting the spirit by which crime is still treated. For, although civilized society has made great advances in framing penal codes on principles of justice, and although government has abolished private retaliation, and itself assumes the prerogative of punishing crime, it has not outgrown the vindictive passions of the barbarous past. The practice of dueling, a vestige of the old private avengement of wrong, is not extinct; and in the prison-treatment and public execution of criminals we still see survivals of the old savage feeling of vengeance that has not yet died out of the community. By the abolition of torture we have conceded

that criminals have rights, but no conception of the correlative rights of the criminal and of society is allowed to determine the kind and degree of punishment. A criminal is one upon whom vengeance is to be wreaked, and this feeling barbarizes the prison overseer, and brutalizes the convict so as to make his existence a curse to himself, and if set free he is more inveterately at feud with society than he was before "justice" took him in hand. What but the spirit of vengeance is it in society which prevents the convict from having all the sympathy of treatment and chance of self-help and amendment that are consistent with his detention in prison as a measure of public security? The surviving spirit of revenge is again seen in the tenacity with which society clings to its brutal modes of execution, turning them into shows for a select company, so that the details may be scattered through the land, and all may enjoy the ghastly accompaniments with which vengeance has been satisfied. In the course of social progress the vengeful feelings have been more and more constrained by the growth of humane sentiments, and their modes of exercise have been transformed, but there is plenty of room for further salutary change.

SCIENTIFIC TEACHING IN THE COLLEGES.

THE gradual acceptance of the doctrine of evolution among our theological friends is causing some perturbation which it is important to notice. Our orthodox contemporary, the "Independent," recognizing the mischief that is being done by the obstinate refusal of religious teachers to accept the conclusions of science, came out strongly in favor of the evolution theory. Dr. McCosh had declared, in addressing the Evangelical Alliance in New York: "It is useless to tell the younger naturalists that there is no truth in the doctrine of development, for they know that there is truth which is not to be set aside by denunciation. Religious philosophers might be more profitably employed in showing them the religious aspects of the doctrine of development; and some would be grateful to any who would help them to keep their old faith in God and the Bible with their new faith in science." The "Independent" took this ground, and in its article upon the subject said: "We are all taught in our best schools, by our scientific authorities, almost without exception (and we laymen in science are, therefore, compelled to believe), that man was, at least so far as his physical structure is concerned, evolved from irrational animals. We, therefore, can not help doubting, as every thinking and scholarly young man [in these schools] must and does doubt, whether the story of the fall in the first Adam is historical."

The cautious and vigilant "New York Observer" now took the alarm. It sent this passage to nine presidents of colleges, and asked them if it was true that it represented the teaching in their respective institutions. Dr. Porter, of Yale, replied, "The inclosed does not give a correct representation of the teaching in this college by our scientific authorities." Dr. McCosh, of Princeton, said: "In answer to your inquiries I have to state that we do not teach in this college that man is 'evolved from irrational animals.' I teach that man's soul was made in the image of God, and his body out of the dust of the ground. I do not oppose development, but an atheistic development." Dr. Chadbourne, of Williams, answered: "The doctrine is *not* taught here that man, even in his *physical nature*, was evolved from one of the lower animals. Wallace, who claims with Darwin the honor of the doctrine known as 'Darwinism,' admits that its principles *fail* when applied to man." President Cattell, of Lafayette, replied: I have never heard of any of my colleagues expressing,

either in private or in the class-room, the opinion referred to in the slip you send me. We are keenly alive here to the danger from what is manifestly the infidel *trend* of the views generally held by evolutionists. It is a great relief to me to know that among all my colleagues there is such a cordial acceptance of the old faith, which it has been the tendency or the avowed aim of these materialistic teachers to destroy." Dr. Brown, of Hamilton, responded: "The doctrine of the 'evolution of man from irrational animals' has never, to my knowledge, been taught in Hamilton College. I trust it never will be till it is proved to be true, as in my judgment it has not been, and I do not think it ever will be." President Potter, of Union, declared, "The printed statement you forward is *not* a correct statement of the teaching in this college." President Robinson, of Brown University, replied, "We do not teach the doctrine stated in the inclosed slip." Dr. Anderson, of Rochester University, protested that "we have never taught in our institution that man is 'evolved from irrational animals,' for the simple reason that we believe the notion to be an unverified hypothesis." And President Seelye, of Amherst, indignantly responded: "This college does not yet teach groundless guesses for ascertained truths of science. So long as the notion that man is evolved from the monkey or from any irrational animal has not a single fact to rest upon, and is in flat contradiction to all the facts of history, I think we may leave it with the sciolists."

Now, this unanimity of unqualified denial has its significant implications. For, if evolution is not taught in those colleges, we may fairly infer that it is because the old alternative doctrine has not been given up; that is, as President Cattell observes, there is among his colleagues "such a cordial acceptance of the old faith." Hence we learn that, on a large question of natural history, nine of the leading American colleges teach the old theological beliefs rather than the conclusions of modern science.

The "Observer" of course exultingly avails itself of the official declarations it has elicited, and points the moral of the case by restating the biological teaching of "the Holy Scriptures," still inculcated in the colleges. It triumphantly asks of the "Independent": "Where are the schools, 'our best schools,' in which its vile doctrine is taught? Degrading as the doctrine is, opposed to the common sense of mankind, contradicted by science and history and the Holy Scriptures, what reckless audacity there is in asserting that it is taught in our best schools!" Again it says: "The Apostle Paul affirms that 'by man came death,' and that 'in Adam all died,' and that 'death reigned from Adam to Moses,' and that 'by one man's offense death reigned by one.' But the 'Independent' says that 'every scholarly young man' must doubt whether the fall in Adam is a fact. The historian Luke traces the lineage of the Son of Mary from son to father, step by step, till he gets back to Seth, 'who was of Adam, who was of God.' This is the Biblical history of development, by which the human race is traced to the time when Moses says God made man and called him Adam. . . . No young person whose mind receives the views of the 'Independent' can at the same time be a believer in the oracles of divine truth. To hold the one is to despise the other. If the irrational animal gospel is true, Christ's gospel is a humbug."

Such is the theological biology to which the presidents of nine American colleges are thus authoritatively construed as committing themselves and their institutions.

Several interesting questions here arise, and the first is an unpleasant inquiry as to how far these presidential declarations are fair and true. Do they represent the facts or do they mislead?

We leave this question to be answered by the "Independent." Having gone behind the returns and looked into the subject, it reports that, in Yale, Professors Marsh and Dana are pronounced evolutionists, and that what is true of these two men is true of Verrill, Brewer, Smith, and of all the other teachers of the biological sciences in Yale College; and it quotes Marsh as having said before the American Scientific Association: "It is now regarded among the active workers in science as a waste of time to discuss the truth of evolution. The battle on this point has been fought and won." As regards Princeton, the "Independent" says: "Dr. McCosh is quite outspoken in defense of the legitimacy of evolution, though not a Darwinian nor a naturalist. Professor Macloskie, their only naturalist, a man who has developed remarkably within a few years, is even more decided in the same direction, as are, without reserve, the distinguished Professors of Astronomy and Physics, Young and Brackett."

In respect to Brown University, we are told that "Professor A. S. Packard, Jr., is the only instructor in zoölogy or botany that we recall in Brown. He fully believes in evolution—man's physical structure no exception—and his published books support evolution through and through."

As to Amherst, "It is sufficient to state that the Professor of Geology in Amherst is an unreserved theistic evolutionist, who teaches the antiquity of the human race, and we have no doubt the same is true of his young colleague in natural history."

The "Independent" then presses the question as follows:

"Why did not the 'Observer' inquire of the President of Harvard College? Probably because he was afraid of the answer he would get. But did he not know that Harvard is one of those 'best schools,' having 'scientific authorities,' which we were talking about; and that Louis Agassiz, the great opponent of evolution, the most influential naturalist that ever lived in America, was a Harvard professor, while Asa Gray, the great American botanist, a champion of religion against materialism, and a devout member of an orthodox church, is another Harvard professor? But its omission was wise. Of all the younger brood of working naturalists whom Agassiz educated, every one—Morse, Shaler, Verrill, Niles, Hyatt, Scudder, Putnam, even his own son—has accepted evolution. Every one of the Harvard professors whose departments have to do with biology—Gray, Whitney, A. Agassiz, Hagen, Goodale, Shaler, James, Farlow, and Faxon—is an evolutionist, and man's physical structure they regard as no real exception to the law. They are all theists, we believe; all conservative men. They do not all believe that Darwinism—that is, natural selection—is a sufficient theory of evolution; they may incline to Wallace's view, but they accept evolution. It is not much taught; it is rather taken for granted. At Johns Hopkins University, which aims to be the most advanced in the country, nothing but evolution is held or taught. In the excellent University of Pennsylvania all the biological professors are evolutionists—Professors Leidy and Allen in comparative anatomy, Professor Rothrock in botany, and Professor Lesley in geology. We might mention Michigan University, Cornell, Dartmouth, Bowdoin; but what is the use of going further? It would only be the same story. There can scarcely an exception be found. Wherever there is a working naturalist, he is sure to be an evolutionist. We made inquiry of two ex-Presidents of the American Association for the Advancement of Science. One wrote us, in reply, 'My impression is that there is no biologist of repute nowadays who does not accept, in some form or other, the doctrine of derivation in time, whatever be the precise form in which they suppose the evolu-

tion to have occurred.' His successor replied: 'Almost without exception, the working naturalists in this country believe in evolution. . . . In England and Germany the belief in evolution is almost universal among the active workers in biology. In France the belief is less general, but is rapidly gaining ground. . . . I should regard a teacher of science who denied the truth of evolution as being as incompetent as one who doubted the Copernican theory.' We challenge the 'Observer to find three working naturalists of repute in the United States—or two (it can find one in Canada)—that is not an evolutionist. And where a man believes in evolution, it goes without saying that the law holds as to man's physical structure."

These, then, are the "sciolists," the smatterers, the shallow novices, to whom President Seelye leaves the subject; meantime the learned professors of Amherst illustrate the dignity of scholarship and the ripeness of knowledge by teaching the biology of the ancient Hebrews. The theory of evolution is now guiding the researches of the scientific world because it is being constantly and increasingly verified in the new results to which it leads; but President Anderson will not teach it because it is "an unverified hypothesis." Has he a verified hypothesis, then? or do they, at the University of Rochester, dodge the foremost philosophic question of the age?

The college presidents seem to resent the imputation that they teach the derivation of man from "irrational animals"; and the "Observer" calls the doctrine "vile" and "degrading." There is a current vulgar belief that the idea of human derivation from inferior animals is scandalous and revolting. But is not this, after all, the established method of producing man? What is a new-born babe but an "irrational animal," and does not each president of a college come from such an "irrational animal" by a process of development? And that is not all. Each human individual, beginning as a protoplasmic germ, is evolved step by step, passing in the gestative period through type after type of "irrational animals" before the developed human life begins. Will the nine doctors of divinity be good enough to say who it was that they think designed this arrangement? And do they not, moreover, teach that the Creator first tried the miraculous method of bringing people into existence at once and perfect, and then abandoned it for the present plan of developing them gradually out of "irrational animals" through the common processes by which inferior creatures are multiplied?

EDUCATION FOR GUIDANCE.

We heard a good thing recently of a distinguished Professor at a distinguished university, eminent for its high-toned devotion to the interests of pure scholarship. The Professor had been lecturing upon a favorite subject, and declared the charm of it to be that "it could not possibly be prostituted to any practical or useful purpose." There is much to admire in this plucky spirit of devotion to truth for its own sake; but it is easy to make this transcendent state of mind subservient to a very bad utility. And, while we value great seats of learning, which provide for the devotees who pursue knowledge for the love of it, we have to guard against the prostitution of this idea to pernicious ends in current education. For, while the exceptional scholar may ignore the practical and the beneficial, the mass of mankind can not do so. They live in a world of action and struggle, and have minds to guide them in their labors and conflicts. These minds require cultivation, that they may do their work better. Knowledge is, therefore, for guidance, and education for the more intelligent direction of the activities and

work of life. But this principle is far from being yet recognized in current education. The lower schools seize upon the higher ethics of university study and pervert them into a defense of their own bad practices. They teach worthless things, on the pretense that the kind of knowledge is of but little account, as education is only concerned with mental training. The crudeness and inefficiency of teaching are excused upon the plea that mental discipline is the thing aimed at in study. Our whole school system is imbued with this vicious fallacy, which is the great obstacle to rationalizing school methods. The knowledge that is of most worth is either not taught or is taught so loosely and carelessly that it is of but little practical use; and the consequence is, that our boys are turned out into the world so ignorant and incompetent that they are defenseless in the exposures of every-day experience.

What shall we say of a system of education which throws its students into society unable to protect themselves from the grossest impostures? To what end is a community filled with colleges, high-schools, and common schools, upon which millions of dollars are spent, when its graduates go out to become the ready prey of charlatans and sharpers, who can enrich themselves by pushing the most absurd and preposterous projects?

We are led to these reflections by the last curious report of lightning-rod swindles. The proud State that gives us our President and Chief Justice, and makes a great ado about its education, has also the honor of originating and harboring "Chambers's National Lightning Protection Company" of Cincinnati. The Americans are a progressive people, great on improvements, and the Westerners are specially wide-awake in this respect. So the new lightning-rod is a great step forward in inventive science. It is laid flat upon the ridge of the building, and turned up at the two ends, and has no connection with the ground. Its *rationale* seems to be that the lightning-discharge is caught upon one of the points, and, there being no rod to convey it to the earth, it is obliged to "diffuse back into the air where it belongs and whence it came." Of course, such an arrangement is worthless for protection, and is, moreover, absolutely dangerous, as every intelligent schoolboy ought to know; and yet such is the grossness of public stupidity that the company drove a thriving business with their contrivance, mounting it upon a great number of private dwellings, and even upon school-buildings. Professor Macomber, of the Agricultural College at Ames, Iowa, seeing the extent to which people were humbugged by this so-called "Protector," publicly denounced it as a fraud, whereupon he was prosecuted by the company, which laid its damages at $50,000. As the thing was getting serious, the Professor concluded to make thorough work with the exposure, and accordingly appealed to a large number of scientific men of the highest reputation, to give their opinion of the "Chambers rod." He has published the replies of Morton, Anthony, Rood, Mayer, Clarke, Baird, Newcomb, Todd, Le Conte, Silliman, Kedzie, Davies, Edison, Trowbridge, Rowland, Young, Hinrichs, Harvey, Pickering, Loomis, and Tyndall, who all agree that it is a worthless humbug, of no use for protection, and an actual danger to any house upon which it is placed. Yet the company will probably suffer but little interruption in its business, as its main stock in trade is public ignorance and credulity. The lightning-rod fiend may be expected to ply his profitable vocation until the common schools do better work than they have accomplished hitherto.

THE abridgment of Judge Daly's recent address before the Geographical Society, on the early history of carto-

graphical art, may be commended to the attention of our readers, but we must remind them that it is a very incomplete representation of the original lecture. A condensation in literature is generally the worst kind of mutilation; for, instead of cutting the thing into large sections by which considerable portions are left unmutilated, the condenser performs his crushing operation on the whole, so that very little is left as the author puts it. Compression is often necessary, but it is generally at the expense of the symmetry and finish of the performance. The President of the Geographical Society expresses regret that his pressure of legal duties during the past year had not allowed him time to work up the progress of current geographical discovery, as he has been in the habit of doing in the preparation of his annual address. But in place of it he has given the world unquestionably the best monograph on the history of map-making in connection with the development of early geography that can anywhere be found. It is a careful statement, laying under contribution all the resources of geographical erudition, and the few small cuts we reproduce from it but poorly represent the full series of old maps that have been prepared to illustrate the subject, and are contained in the pamphlet issued by the Geographical Society. To that document the reader is referred for the ampler and more satisfactory discussion of the subject.

LITERARY NOTICES.

OCTAVIUS PERINCHIEF: HIS LIFE OF TRIAL AND SUPREME FAITH. By CHARLES LANMAN. Washington: James Anglim. Pp. 403. Price, $2.

THIS is the biography of a devout clergyman, who was at the same time a cordial and fearless friend of science. We call attention to some features of the work that illustrate this combination of traits.

The subject of it was born in Bermuda in 1829. He got the rudiments of a common education there, and came to New York at the age of eighteen. Having a thirst for study, and deciding to become a clergyman, he went to Amenia Seminary, and then to Trinity College at Hartford. After graduating there he taught a year at Racine College, Wisconsin, and then wound up his professional studies in the General Theological Seminary in New York. He was ordained by Bishop Potter as a clergyman of the Episcopal Church in 1857.

Mr. Perinchief's pastoral experiences were varied. He had charge of several parishes, beginning to preach in Brooklyn; he afterward went to Bridgeport, then to York, Pennsylvania, from which he removed to Mount Holly, New Jersey, and finally returned to Bridgeport, where he died in 1877, at the age of forty-seven years.

Mr. Perinchief was during all his adult life an invalid and a great sufferer. Straitened in means, and fighting his way through the educational institutions, he was often subjected to great privations, living for long periods on bread and water, with insufficient clothing, which, with the customary overwork in such circumstances, permanently impaired his constitution. Besides this, he early met with a terrible accident which produced a lesion of the spine, that was ever afterward a source of much pain and prostration.

It is hardly possible that so intense and prolonged an experience of physical suffering could have been without its influence upon his mental life. Yet he was far from being the victim of his bad bodily conditions. His subjective experiences did not color or distort his view of the world. His manhood triumphed over the unhappy accidents of his lot, and the influence he exerted upon all around him was in a remarkable degree healthful, ennobling, and purifying. He had a large measure of that quality which is currently characterized as "personal magnetism," and all who knew him were brought under its influence, and quickened in their aspirations after a higher and more perfect life. He was a man of great spirituality and profound devotion, but this involved no weakness, and he did not waste himself in mere fervid emotion. His judgment was clear, his criticisms telling, and his views

independent. Though in the Church heart and soul, he was not a blind partisan, but saw the evils that were near, and the good that was beyond. Liberal in his ideas and catholic in his sympathies, he was unsparing in his condemnation of the selfish worldliness that he encountered in his own sect, and cordially responsive to all the noble work of the age whether within or without the pale of ecclesiasticism.

There were a simplicity, modesty, and intense earnestness in this man's nature, such as are but rarely observed. Though gifted as a preacher and capable of brilliant mental work, he never courted popularity, nor sought conspicuous positions. Often solicited to enter the higher sphere of churchly recognition and influence, he steadily resisted these importunities, preferring obscurity, and quiet, unobtrusive labor among the common people that had not been spoiled by affluence. He was very radical in his convictions in regard to ministerial duty, as may be gathered from various passages of his correspondence. In a private letter written from Boston, in 1869, he speaks very plainly: "This morning I preached in an old wealthy and dead church. To preach to such a people is like preaching to a field of old stumps and about as hopeful. . . . I thank God that we are not rich, and that our lot is not, and has not been, cast with the rich. I tell you the rich can hardly enter into the kingdom of heaven, whether they be clergy or laity. . . . I feel that we are all relying too much on money—great stone churches, fine houses, large salaries, etc., which have brought the Church to the level of the world. I see the rich, full of pride, taken up with vanity, soul all gone, thinking their gain is godliness, no sympathy, no *true* riches of any kind."

Again he breaks out: "I am more and more convinced that a hired ministry is a great evil. To preach honestly under such circumstances almost kills me; to preach tenderly is almost impossible. To take pay for preaching is base and unmanly; I feel it more and more every day. To be in the position of a divine teacher and not preach according to my conscience is impossible, and so, what with one thing and another, the difficulty of doing one's duty—the sense of begging or being a hireling—almost drives me out of the ministry. I ask myself: Is this all that eighteen hundred years can accomplish for man by the Church, and in the Church? Italy could not be worse off without her Church. How is it with the United States?"

In regard to science Mr. Perinchief was large-minded and sympathetic, although his acquisitions in this direction were of course slender. Neither his early education in the parish-school at Bermuda, nor his subsequent training at Amenia Trinity College and the New York Theological Seminary, could have been well adapted to inform him of the great truths of modern science, or to create any special interest in this line of study. But the instincts of his liberal intelligence were true to the spirit of improvement and progress, and, as his mind widened by observation and reflection, he saw clearly enough that science is to be the great renovating agency of modern times. In this relation his biographer remarks: "The scientists who wrote on evolution, as well as those who uttered striking thoughts in theology, literature, art, philosophy, or statesmanship, he devoured with equal gusto; and, discriminating between facts demonstrated to be true and those purely theoretical, he was always ready with a criticism or decided opinion on the merits of what he read. He accordingly saw nothing in science to cause alarm, but welcomed it as a grand agency of human amelioration, in emancipating men from superstition, and in making those great conquests of Nature that have been so powerful in elevating mankind from barbarism and carrying on the work of civilization. Nor could he understand how a deeper knowledge of the method and mysteries of Nature can have any other effect than to exalt and purify the conception that man forms of the Creator and Ruler of all things. His faith was not of a kind to be disturbed by any progress of knowledge. He therefore held all true men of science who dedicated themselves to the elucidation of the works of God as promoters of religion in its best and highest sense. He cheered on the labor of scientists, commending their single-minded and unswerving devotion to the pursuit of truth, not in any skeptical spirit, but as a simple dictate of Christian principle."

The illustrations of these sentiments, occurring in Mr. Perinchief's letters, are noteworthy. He was a careful reader of this magazine, and thus wrote concerning it to his friend Mr. John A. Graham, of New York: "I am exceedingly obliged to you for that copy of the 'Science Monthly'; I am much delighted with it. This is an enterprise I would very gladly see prosper in this country. It is very much needed, and I believe it will be sustained. It will help men who are now thinking along their own solitary lines; it will stimulate thought in those who have not thought before; it will gradually elevate the tone of our entire literature. If it can only get among our church people, it will make many of them more truly religious. Success to it."

Again he wrote to the same gentleman regarding two books bearing in opposite directions upon current controversies.

Draper's book is better than I expected to find it. I knew it was a *book with something in it*, but I find a *great deal* in it, and I am satisfied there is a great deal more in it than he has put in so many words upon the face of it. This book, like many others of recent origin, convinces me that there is such a thing as the *spirit of an age*, a something which turns the general mind in a given direction. It startles me a little to find, in books, things which I have dug out little by little. It startles me to find, in black and white, conclusions at which I have very reluctantly arrived, which I have tried to resist, but at last found irresistible. And there are yet other things which must come, for there is much that is "rotten in Denmark"!—other things which have made me sick in discovering them, and now make me sick in contemplating them. What changes the last twenty-five years have wrought! How much greater changes the next twenty-five years will work! All too late, however, for me personally; I was born too soon or too late. The churches, the ministry, the theology of the past will not do for the future. The new wine can not be put into the old bottles. . . .

The Duke of Somerset's book is hardly a book. There is really very little in it. It is not a spontaneous production of his, it is a mechanical collection of scraps, things somebody else has evolved; many of those things are true enough, but they lack life. Some of them are not true at all, only "my Lord Duke" don't know it. In some cases he don't even see the idea he wants to hit. He simply fires up the tree, violating Davy Crockett's first law of shooting. The work of the true seer is not destruction, but construction. If the Duke had lived fifty or a hundred years ago he would have been in his proper time. Any landsman can see the waves and the storm and the rocks, but the true pilot is the man who takes us safely past them. Men like Draper and Arnold show us a continent ahead. The Duke of Somerset only tells us there is not one behind us.

Some of Mr. Perinchief's sermons have been published, but are out of print; new editions are announced. They are remarkable for vigorous simplicity of style, warmth of religious feeling, and independence of thought. Mr. Perinchief's position in the Church was similar to that of Frederick Robertson. There is much likeness in their intellectual work, and in the opinion of many the excellences of Mr. Perinchief's discourses are quite equal to those of the eminent and liberal English clergyman.

THE ARCTIC VOYAGES OF ADOLF ERIK NORDENSKIÖLD FROM 1858 TO 1879. With Illustrations and Maps. London: Macmillan & Co. 1879. $4.50.

NORDENSKIÖLD occupies an eminent position among the explorers of Arctic lands. For upward of twenty-one years, or since 1858, he has devoted his great abilities to that laborious and often perilous work. Accounts of his researches and discoveries have appeared from time to time, and the Swedish Arctic and Polar Expeditions planned by him, or in which he took a conspicuous part, have a wide fame, and are rich in results. The latest expedition undertaken by the great explorer was a successful effort to reach Behring's Strait and the Pacific Ocean from Norway by way of the Kara Sea and the Arctic Ocean. In this and in two previous expeditions along the north shores of Europe and Asia an extensive series of observations was made of the greatest importance to commerce and to science. The coast-line was well determined and mapped, soundings were made, and a record kept of meteorological and magnetical observations. Besides these, some of the great rivers which empty into the Arctic Sea were explored; the important fact was shown that the northern lands of Siberia are not only highly fertile, but are susceptible of cultivation; and that a vast pine forest of gigantic growth extends northward of the Arctic Circle, stretching from the Ural quite to the Sea of Okhotsk. Many more plants were found at home in higher latitudes in Siberia than in Sweden. The white and red currant

grow in great luxuriance on the banks of the Yenisei in the north forest region.

The volume before us was prepared by Alexander Leslie, Esq., of Aberdeen, and, although largely a compilation from reports and papers by Nordenskiöld and his able scientific assistants, has been put together with rare tact and judgment, and forms an interesting and timely contribution to the literature of Arctic exploration.

The first voyage of Nordenskiöld to Spitzbergen was made in 1858 as geologist in Jorell's first expedition to that island. It was then that he discovered, at Bell Sound, on the southwest part of Spitzbergen, the remarkable fossil flora which was determined by Professor Heer to be of Tertiary age. He also found in the same fiord limestone in vertical strata, which, from its fossils, is referred to the Carboniferous formation. In the spring of 1861 another voyage was made, and the work of exploration begun in 1858 was pushed with vigor. On this journey, while yet many miles from Spitzbergen, snow-buntings, exhausted in their migratory flight, alighted in the rigging of the ship. On another occasion, flocks of the barnacle-goose were seen flying northeastward beyond Spitzbergen, perhaps to yet unknown lands. When the breeding-season for birds was at its height, the vast numbers seen astonished the travelers. The rocks of the coast for many miles were literally covered with them.

Nordenskiöld made six voyages of exploration to Spitzbergen, and one to Greenland. This last was in 1870, and the account of his journey inland is of great interest. He proceeded to the head of Auleitsivik Fiord, and went thence about thirty miles over a region that was one vast ice-field, dangerous and exhausting to travelers. They reached a point twenty-two hundred feet above sea-level. A pair of ravens were the only animals seen, but traces of the ptarmigan were met with. In the Polar Expedition to Spitzbergen in 1872–'73, a very extensive exploration of the eastern shore of Northeast Land was made. This is a desolate, ice-covered island about ninety miles in length by seventy-five in breadth, separated from Spitzbergen by a strait eighteen miles broad. The ice-covering is probably from two to three thousand feet in thickness, and the movement of the ice-mass is eastward, forming the broadest glacier known. Its breadth is even greater than that of the Humboldt glacier of Greenland.

The book abounds in fine descriptions of Arctic scenery, and the long night seems to be not wanting in agreeable aspects. The darkness is lessened by the mild light of the moon; and a faint, reddish glimmer in the southern horizon lingers for some time, a reminiscence of the day and of summer. Overhead the pole-star shines with steady luster, and the vault is all aglow with stellar light. On the shore, in the ice-slush, a phosphorescent glow is frequently observed, due, it is supposed, to the presence of minute crustaceans, and this phenomenon continues even at a temperature of 10° Cent. below freezing.

The results of Nordenskiöld's last voyage, in which he passed Behring's Strait and entered upon the Pacific Ocean, are briefly stated, and the fuller account from the pen of the explorer will be awaited with interest. The Vega, the vessel in which this important voyage was made, was detained by ice but a few miles from the strait, for two hundred and sixty-four days. It made the passage of the strait on the 20th of July last, and demonstrated the practicability of navigation from the North Atlantic to the North Pacific. The volume is appropriately dedicated to Oscar Dickson, of Gothenburg, whose princely liberality made the several expeditions possible.

AN ILLUSTRATED DICTIONARY OF SCIENTIFIC TERMS. By WILLIAM ROSSITER. New York: G. P. Putnam's Sons. Pp. 350. Price, $1.75.

BOOKS of this kind are much needed, as our scientific literature is becoming burdened with a great multitude of new technical terms, many of which are not found in ordinary dictionaries. But this work does not profess to be complete. Only the most commonly used and most important words have been included. The compiler has aimed at accuracy and brevity, and seems to have fairly secured both. We might object to the smallness of the type, but 14,000 entries got within moderate limits of course necessitate small type.

THE ENGLISH LANGUAGE AND ITS EARLY LITERATURE. By J. H. GILMORE, A. M., Professor of Logic, Rhetoric, and English in the University of Rochester. New York: D. Appleton & Co. Pp. 138. Price, 60 cents.

THIS is a small book, but a valuable one. It assumes that there is need in our schools of a much more thorough study of English, and it opens the way to this study by a rational method. The usual study of language, as an isolated and arbitrary acquisition—an accumulation of words in the memory in their mere verbal relations—is one of the driest and most repulsive of mental occupations. Grammar is undoubtedly more responsible for that hatred of the schoolroom, and all that belongs to it, which is one of the common results of education, than any other subjects. The laws of mind, like the physical laws, vindicate themselves. The young intellect instinctively revolts at the drudgery of grammatical word-grinding, and in all history the teacher tries to counteract this tendency by the use of the rod. There is no reason or necessity for this; it is simply the result of a vicious method. The subject is capable of deeply interesting all minds of sufficient maturity to begin to recognize the relations and meanings of things. As Professor Gilmore says, the study of English literature "may be made one of the most interesting by associating the literary with the political and social history of the people; by withdrawing attention from the minute details of literary history, and fixing it only on salient points; by studying authors as well as studying about authors." The professor cuts the knot at once by taking the evolution point of view. He says: "We propose, then, to consider the origin and development of the English language; and to approach that subject—as, indeed, it can only be intelligently approached—from an ethnologic and historic point of view. In studying the philology of a people, we *must* at the same time study their ethnology and history. We can have no just conception of English literature unless, as we trace its progressive development, we couple with it the gradual unfolding of English political and social life." He goes on in the same strain; "The present *character* of a people is largely determined by the character of their ancestors, and the circumstances in which those ancestors were developed. The *political institutions* of a people are but the unfolding of a germ implanted centuries ago, and matured by all the influences to which that people has since been subjected. So it is with the *literature* of a people. All the past enters into the present, and makes it what it is. The present will enter into all the future, and give it character. A nation's literary history records the germination and growth, through shade and sunshine, of seeds which were implanted in the soil centuries ago—the development of principles which are as old, to say the least, as the language in which they are to-day embodied. Hence, to apprehend fully the literary character of any age, we must submit ourselves to the formative influences which have made its literature what it is. Thoroughly to understand the dramas of Shakespeare, the essays of Bacon, the poems of Milton, we must go back into the dim and dusty past, and learn how Shakespeare, Bacon, and Milton came to think and speak as they did; for no one even of these master minds was sufficient unto himself—they were all more or less indebted to the past. What has been said with reference to English literature is equally true—indeed, rather more true—with reference to the English *language*. In order thoroughly to comprehend and effectively to use the English of the present day, we must study the English of the past—we must know the language, not merely in its developed form, but in its germinal principles."

The book is obviously the result of wide and critical reading, and much experience in teaching. It makes no formal claim as a text-book, but competent instructors will find ways to make it useful. It contains copious notes, and many references to works suitable for consultation by students.

DARWINISM AND OTHER ESSAYS. By JOHN FISKE, A. M., LL. B. Macmillan & Co. Pp. 283. Price, $2.

THIS volume consists of various articles contributed by its author to the periodicals, and he has done well to collect them in this convenient and accessible form. The book opens with three or four papers on various aspects of "Darwinism," but its chief con-

tents are not described by this title, though they all treat of kindred questions raised by the progress of recent inquiry. Although not a systematic treatise, this collection will be valuable to students of contemporary thought. It may be strongly commended to general readers upon those subjects, as introductory to more methodical works. The book is in an eminent degree of the explanatory and helpful sort which, by brief incidental explanations, often succeeds in aiding the learner where more formidable disquisitions fail to be apprehended. All who are perplexed with imperfect apprehension of evolutionary doctrines will find these essays especially instructive and useful. They are not only full of valuable thought, but they make the topics plain and interesting to unproficient minds.

MEMOIRS OF THE SCIENCE DEPARTMENT, UNIVERSITY OF TOKIO, JAPAN. Vol. I., Part I. Shell-Mounds of Omari. By EDWARD S. MORSE, Professor of Zoölogy, University of Tokio. Published by the University of Tokio, Japan. Nisshusha Printing-Office. 2539 (1879).

THIS monograph of Japanese archæology has much more than the usual interest of such documents. In the first place, it emanates from a university that has recently arisen in the great city of Tokio, which has a vigorous scientific department, and is filled with native students, who are pushing with enthusiasm into the field of original work. Several English-speaking professors have been called to take positions in this institution—the heathen being apparently more appreciative of the missionaries of science than the missionaries of the gospel. Professor Morse, of Salem, who has for the past two or three years been carrying on the good work of zoölogy in the Tokio University, has also interested himself in Japanese ethnology and the relics of its old civilization. It is curious that, when we get back sufficiently far in time, modern distinctions disappear, and we are lost in a prehistoric antiquity which discloses common features all over the world. The mound-deposits of Japan early attracted Professor Morse's attention. He had already studied these phenomena in Massachusetts and Maine, with Wyman and Putnam, and was prepared to keep a sharp lookout for evidence of their occurrence in the East. Soon after his arrival he fortunately discovered a large and extensive shell-mound on the line of the railway at Omori, six miles from Tokio. The students of the university joined him in exploring it, and many interesting specimens of pottery, implements, and weapons were obtained, which are preserved among the collections of their Archæological Museum in Tokio. The present memoir is descriptive of those specimens. Appended to the text of this memoir are eighteen large lithographic plates on folding pages, and containing two hundred and fifty illustrations of archæological subjects. These lithographic representations are excellently done, and were all drawn by Japanese artists. Nor is this all: the composition and press-work of the volume are the work of Japanese printers, the type being set by compositors unable to speak a word of English. And, what is more, the paper upon which the book is printed is of Japanese manufacture. The paper is superior, the typography excellent, and the printing first rate—in fact, for a "heathen" production the work is highly creditable.

FUEL: ITS COMBUSTION AND ECONOMY. Edited by C. KINNARD CLARK, C. E. D. Van Nostrand. Pp. 394. Price, $1.50.

THIS volume is a combination of two works, one by C. Wye Williams and the other by J. S. Prideaux, on the general subjects of the combustion of coal, the structure of furnaces, and the atmospheric conditions of high thermal effects. It is fully illustrated, and forms a very complete manual of the subject.

UNITS AND PHYSICAL CONSTANTS. By J. D. EVERETT, F. R. S. Macmillan & Co. Pp. 175. Price, $1.10.

THIS is a valuable digest of what may be called the data of the physical sciences—the units, constants, standards, and symbols of the foundation facts of the most important branches of physical science—mechanics, hydrostatics, astronomy, sound, light, heat, magnetism, and electricity. Treating of the basal conceptions of quantitative science, its expressions are of course in mathematical form. It is a valuable book for critical students, and done by a first-class man.

SOLAR LIGHT AND HEAT: THE SOURCE AND SUPPLY. Gravitation; with Explanations of Planetary and Molecular Forces. By ZACHARY ALLEN, LL. D. D. Appleton & Co. Pp. 241. Price, $1.50.

DR. ALLEN published an elaborate work in 1851, entitled "The Philosophy of the Mechanics of Nature." The present volume is a sequel to that publication, and, besides embodying its results, it involves further researches into the origin of molecular forces, of gravitation, and also of solar light and heat. The author's fundamental idea is, that molecular forces have their origin in the mechanical motions of great masses of matter; or that the heat, light, and radiant energy of space, acting upon the earth to produce all its activities, originate in the rotary and orbital movements of the sun and planets. The radiant forces are engendered and transmitted by means of a universal, electric, ethereal medium; and a large portion of his volume is devoted to an elucidation of electrical effects and laws which go to prove that the solar system is a mighty electric and electro-magnetic engine. Dr. Allen's views are comprehensive and interesting; it is for physicists to judge of the evidence of their validity.

FIRST BOOK OF QUALITATIVE CHEMISTRY. By ALBERT R. PRESCOTT, Professor of Applied Chemistry in the University of Michigan. Van Nostrand. Pp. 160. Price, $1.50.

THIS volume has been prepared primarily for use under teachers who also employ the author's larger work upon Qualitative Analysis. It is, therefore, a working laboratory-book, useful for classes who desire to take a short course in practical, qualitative chemistry. It is designed to afford as much insight as possible into chemical action, and prepares for a more definite study of acids and bases than is usual in such rudimentary books. The name of the author gives assurance of the excellence of the work.

ELECTRO-METALLURGY PRACTICALLY TREATED. By ALEXANDER WATT, F. R. S. S. A. D. Van Nostrand. Pp. 195. Price, $1.

HERE is the sixth edition of a technological hand-book, the merit of which is thus fully attested; for those who have bought it are naturally those who wanted to use it, and it has thus been subjected to the sharpest trial. It describes the processes of electro-gilding, electro-plating, and coating of surfaces by electro-deposition; and is full of the information required by the artisan in this field of industry. The volume is an interesting record of recent improvements, and is especially full in details concerning the electro-deposition of nickel, which is just supplanting silver as a protective and ornamental coating for other metals.

PUBLICATIONS RECEIVED.

The Californian. A Western Monthly Journal. Vol. I., No. 1. January, 1880. San Francisco: The A. Roman Publishing Co. Pp. 100. 25 cents a number, $3 a year.

Industrial Education, or the Equal Cultivation of the Head, the Heart, and the Hand. An Address, by Professor Alexander Hogg, before the National Educational Association at Philadelphia, July 31, 1879. Pp. 15.

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POPULAR MISCELLANY.

Geology of the Far West.—Last summer Professor Geikie, of the University of Edinburgh, came over here to study the geology of our Western Territories, the remarkable peculiarities of which have excited much interest abroad; and he has recently made his explorations the subject of a very interesting lecture before his class. From a summary of the discourse, published in "Nature," we gather the following instructive particulars: Professor Geikie had three objects in view in the expedition: 1. To study the effects of atmospheric and river erosion upon the surface of the land; 2. To mark the relation which the structure of the rocks underneath bore to the form of the surface; and, 3. To watch some of the last phases of volcanic action. In crossing the prairies toward the Rocky Mountains he noted the singular fact that their surface was "veneered" with a thin coating of pinkish, fine-grained sand, its color being due to small pieces of fresh feldspar. It was clear that this mineral, as well as fragments of quartz and topaz found with it, did not belong to the strata on which they lay. In going west, the grains of sand, getting coarser, assumed the form of distinct pebbles, and on reaching the mountains became huge blocks and bowlders, evidently derived from the heights beyond. The name, "Rocky Mountains," the Professor regards as singularly misapplied. On most maps of North America a continuous line of lofty ridge is represented as extending down the axis of the continent, and marked "Rocky Mountains." No such ridge, however, is to be found. The great plateau had been wrinkled by numberless meridional folds, which, dying out, have been replaced by others. Some of these folds form mountain-ranges with wide basins between them. It is, however, possible to cross the axis of the continent without climbing over mountains of any kind, and the Union Pacific Railroad follows one of these natural routes. So little did the landscape suggest great altitudes that at an elevation of eight thousand feet a wooden placard had been erected, bearing the title "Summit of the Rocky Mountains." Going westward to Denver, the Professor halted on the borders of the great mountain-range that forms the bulwarks of the parks of Colorado. These crests of crystalline rock have been forced up like a great wedge through the cretaceous and tertiary strata of the prairies, carrying the latter up with them in a grandly picturesque curve along their flanks. An excursion into some of the mountain gorges or cañons brought to light the source of the pink feldspar sand of the prairie; great masses of pink granite, gray gneiss, and feldspar form the core of the mountains; these are visibly crumbling into the same kind of pink sand and gravel. The mountains have been covered with glaciers which have flowed out into the plains, and there shed their huge horseshoe-shaped moraines. Having crossed the watershed of the continent, Professor Geikie struck westward into the Uintah Mountains, one of the few ranges in that region that has an east and west direction. It forms one of the most remarkable elevations in North America. Unlike the other mountainous high grounds it possesses no great central core of crystalline azoic rocks, but consists of a vast flattened dome of red sandstones, dipping steeply down beneath mesozoic rocks on either flank. One feature of surpassing

interest in the Uintah Mountains is the evidence of enormous denudation, continued through a protracted cycle of geological time. The horizontality of the strata along the central parts of the range is such that terrace above terrace can be traced by the eye for miles around any commanding peak. The rocks there have escaped crumbling and fracture to a remarkable degree. It can therefore be seen that the deep gullies and clefts, the yawning precipices and cañons, the wide corries and vast amphitheatres by which the surface is so broken up have been produced not by underground disturbances but by erosion at the surface. Most of this tremendous denudation has doubtless been effected by ordinary atmospheric action. One of the valleys in this section he describes as crossed by beautiful horseshoe moraines that had once formed a succession of lakes, the sites of which are now occupied by meadows. In these and other high grounds, the beaver, by its dams, has converted the small streams into a succession of shallow lakes, and hundreds of acres of bog-land have been thus produced. The grand cañon of the Yellowstone, gouged out of volcanic formations, Professor Geikie described as exhibiting, perhaps, the most marvelous piece of mineral color to be seen anywhere in the world. It has been cut out of tuffs and lavas, showing sulphur-yellow, verdigris, or emerald-green, vermilion, crimson, and orange tints, so remarkable that, if transferred to paper or canvas, they would be pronounced incredible and impossible. In the Yellowstone Valley abundant evidence of extensive glacial action was found. On entering the second cañon in their ascent of the valley, it was seen to be most exquisitely glaciated from bottom to top, thus making it clear that the cañon was older than the glacial period; it had supplied a channel through which the glacier had ground its way out from the mountains. According to the indications on the sides of the valley, this glacier must have had a thickness of sixteen or seventeen hundred feet. The Professor next described the famous geyser region. The ground was honeycombed with holes, filled with boiling water. One geyser, known as "Old Faithful," went off with wonderful regularity every sixty-three minutes; the others were more variable. The "Devil's Paint-Pot," a mud-geyser, boiled like a great vat of thick porridge, throwing out white and brilliantly colored mud. Professor Geikie acknowledges with admiration the labors of the explorers who first made known the wonders of this remote and inaccessible region. The reports of Hayden and his associates were found to be most trustworthy and useful. Nor could one forget the sagacity with which Hayden proposed, and the enlightened liberality with which Congress enacted, that for all time the Yellowstone region should be a tract set apart as a national park for the instruction and recreation of the people. On reaching the basin of the Great Salt Lake, our traveler was impressed, by the evidences on every hand of the former vast extent of this inland sea. Lines of terrace ran along the sides of the mountains, the highest standing a thousand feet above the present level of the water. The rocks in some of the cañons descending from the Wahsatch Mountains, in the Salt Lake Basin, were found smoothed, polished, and striated by the glaciers that had come down from the heights above, bringing with them great quantities of moraine matter. Mounds of rubbish blocked up the valleys here and there, and some of them were observed to descend to the highest terrace. Hence, when the Salt Lake extended far beyond its present area, and was about one thousand feet deeper than now, the glaciers from the Wahsatch Mountains reached its edge, and shed their bergs into its waters. Bones of the musk-ox had been found in one of the terraces, showing that Arctic animals lived in this region during these cold ages.

Death of Professor B. F. Mudge.—We have to record the death, at his home in Manhattan, Kansas, on the 21st of November last, of Professor B. F. Mudge, whose geological and paleontological researches and writings had gained for him a high place among Western men of science. Professor Mudge began his working life at the age of fourteen as a shoemaker, but at twenty fitted himself for college, and entered Wesleyan University, where he graduated in 1840. He then studied law; was admitted to the bar in 1842, and for the

next seventeen years practiced his profession in Lynn, Massachusetts, of which city he was elected the second Mayor. In 1859 he went West, and took the position of chemist for the Breckenridge Oil and Iron Company in Kentucky. When the war broke out he removed to Kansas, and in 1863 received the appointment of State Geologist. In 1865 he was elected Professor of Geology and Associated Sciences in the State Agricultural College, a position he continued to fill for eight years. Since 1874 Professor Mudge has thoroughly explored the geology of Kansas, describing for Professor Hayden the Tertiary and Cretaceous formations of the State, and making extensive collections for Professor Cope, including among other interesting fossils the discovery of one of the earlier if not the earliest specimen of toothed birds found in this country. More recently he was employed by Professor Marsh as field geologist of Yale College, and has since made large collections in the West for the Peabody Museum. Professor Mudge was a member of the American Association for the Advancement of Science; and was one of the founders of the Kansas Academy of Sciences, and its first President. He also took a deep interest in the cause of general education, and was offered the position of State Superintendent of Schools in Kansas; this, however, he felt obliged to decline, in obedience to his preference for active scientific work. Indefatigable as an observer, Professor Mudge was also a clear and interesting writer; and it is to be hoped that his numerous scientific papers will yet be brought together for permanent preservation in book-form.

Zoölogical Work at the Chesapeake Laboratory.—In a brief report to the President of Johns Hopkins University, Professor W. K. Brooks, of that institution, gives an interesting outline of the investigations carried on during the past summer in the Chesapeake Zoölogical Laboratory of which he was in charge. The laboratory opened at Crisfield, on the eastern shore of the bay, June 25th, having its quarters in three barges belonging to the Maryland Fish Commission. There were a dozen gentlemen in attendance, most of them trained observers, and the amount of work accomplished during the session Professor Brooks describes as very satisfactory. Later in the season the mosquitoes made the barges uninhabitable, and the party was obliged to move to Fort Wool, where its work was continued until September 15th, making the length of the session eleven weeks. Dr. S. F. Clarke, assistant in the Zoölogical Laboratory of Johns Hopkins, devoted most of the season to the study of hydroids, and found that many of the species which occur in the bay are new to science. Besides describing a number of these, he was able to make important observations on their structure, manner of growth, and other points of interest. Professor E. A. Birge, of the University of Wisconsin, made a very complete series of observations on the larval stages of two genera of crabs, tracing them from the egg to the adult form; and prepared a full set of drawings showing each appendage at each stage of development. A careful study of the development of the edible crab was attempted, but stormy weather prevented a completion of this work, which it is suggested should be taken up again another season. Concerning his own investigations, which were mainly directed to the development and artificial propagation of the oyster, Professor Brooks states that he obtained information on a number of obscure points in molluscan development, and also reached very unexpected conclusions regarding the breeding habits of the American oyster which he believes will prove to be of great economic importance. Owing to the difficulties attending such investigations at the ocean, much of the work begun was left incomplete; several of the researches, however, were carried far enough to warrant publication, and a number of papers have been prepared that are now ready for the press.

Progress of the Electric Light.—Mr. Edison has been vigorously prosecuting his investigations in relation to this subject, in the laboratory at Menlo Park, and has lately announced an important step forward. His task has been to get an electric lamp that would work satisfactorily in giving out only the light of a common gas-burner. The carbon-points and arc would not answer. He labored a long time to make

platinum in some form serve as the wick of his lamp, to be made luminous by the current. But, this failing to meet his requirements, he cast about for other materials. He tried carbon in various shapes, and at length hit upon one form of it which he thinks promises to solve his problem successfully. He cuts out a slender piece of paper from cardboard, in the shape of a horseshoe, about one inch and a half long, and not thicker than a knitting-needle. This is then carbonized by pressing it between metal plates, which are raised to a high temperature. This little slender carbon-loop, which preserves its fibrous character, so as to make it somewhat elastic, is clamped to the conducting wires, at each end, and is then introduced into a little glass globe, two or three inches in diameter, which is exhausted of air, and immediately sealed up. By improvements in the Sprengel pump, Mr. Edison claims to get a vacuum so perfect that but one millionth of the air remains in it. As the current passes through the carbon it heats it to a glowing whiteness, so that it gives out a very pleasant, moderate light. These lamps, it is said, can be made very cheaply, and it is claimed that thus far the carbon filaments withstand the influence of the current and promise to be permanent. It would, of course, be premature to pass judgment upon that which time alone can determine.

About Snakes.—The question how snakes progress is answered by the books in a way satisfactory to many minds, but Mr. H. F. Hutchinson, who writes about them in a recent number of "Nature," takes some exceptions to the usual explanation. He seems to have been a careful observer of their habits, and concludes that terrestrial snakes move in one or the other of the following ways: "1. On smooth, plane surfaces, by means of their rib-legs; e. g., the boa. 2. Through high grass, by a rapid, almost invisible, sinuous onward movement, as the hydrophidæ in water; e. g., the rat-snake. 3. Climbing trees, or ascending smooth surfaces by erecting their abdominal scales, or using them to produce a vacuum, as lizards do their foot-scales for ascending smooth surfaces; e. g., tree-snakes and cobras." Mr. Hutchinson captured a snake nine inches long, with a head less than half an inch broad, and presented it with a frog two inches long and one broad. The snake saluted the frog by seizing it by the nose. The animal made desperate attempts to shake it off, but in vain, and all the while the process of deglutition (?) was going on, or rather the snake was slowly but surely getting outside the frog. This was accomplished by a sort of vermicular process. The sharp little teeth were seen to advance slightly, and then the whole body wriggled up to a new hold on the frog. In this way it very gradually disappeared, the whole process lasting half an hour. The so-called snake-charming Mr. Hutchinson is confident is only clever *legerdemain*. He describes the operation of skin-shedding as follows: "The skin ready to be cast yields round the snake's mouth only, and remains adherent to the extremity of the tail. As the animal advances, the caudal extremity of the skin is inverted—that is, pulled inward—and so the process goes on, and is completed by the tail passing through the mouth of the skin; and thus the direction of the abandoned skin is directly opposite to the direction taken by the skin-casting snake—that is, if the mouth of the skin lies east, the snake went out to the west."

Improvements in Butter-making.—English farmers of late years have been giving more and more attention to the improvement of their dairy products, and in the business of butter-making, especially, have made some very considerable advances on the old-time practice. One of the most recent and one of the most important of these is the discovery of an odorless, tasteless, and quite innocuous antiseptic that proves to be an effectual preservative of butter, without the use of salt, and without the usual precaution of excluding it from the air. To test its efficacy, the patent was submitted to Mr. G. M. Allender, a disinterested expert in London, for trial. On the 24th of July last he treated a churning of butter in accordance with the directions specified, and, inclosing the butter in a muslin cloth, placed it in a firkin without a particle of salt—every precaution being taken that there should be no tampering with the experiment. The firkin remained on the

premises at St. Petersburg Place, Bayswater, for three months, and when examined on October 24th the butter was as sound and sweet as when first put in, although during the whole time it had practically been exposed to the air, nothing having been done to exclude the latter from the firkin. Without treatment it would undoubtedly have become wholly putrid in that length of time; nothing, however, could be detected by either smell or taste to indicate that the sample had suffered the slightest deterioration, as it possessed all the qualities of flavor and firmness of butter churned the day before. Experts in different parts of the country were furnished samples, and all pronounced the preservation wonderful; they were of the opinion, however, that the best, newly-made butter has a peculiar aroma that is not quite equaled in the preserved butter, while the latter was considered a little "dead," a defect that is removed by the addition of one per cent. of salt. The cost of the preservative does not exceed one halfpenny per pound of butter; it is worked in directly after churning, and requires no further care or attention, except that, like other butter, it should be kept in a moderately cool place.

Are Bacteria found in Healthy Animals?—In the "Journal of Anatomy and Physiology" for April, 1878, Messrs. Chiene and Ewart asserted that bacteria did not exist in the organs of healthy living animals. In the August number of the "Journal für Praktische Chemie" Messrs. Neucki and Gracosa urge the affirmative side of the question. The chief points of the latter's argument we abstract from a recent copy of "Nature": Dr. Burdon-Sanderson plunged an organ from a newly-killed animal into paraffine heated to 110°, it was allowed to cool and then covered with Venetian turpentine to still further protect it from outside infection. Two days after, the organ was found in a clotted and slightly cooked condition on the outside, but bacteria were present in the center. To this, Messrs. Chiene and Ewart replied that the bacteria-germs fell upon the organ in the interval between its extraction and the moment of plunging it into paraffine. This was accordingly guarded against by an antiseptic method, and three days afterward, when the specimens were examined, no bacteria were discovered. The conclusion, therefore, of Messrs. Chiene and Ewart was that, if the organs were treated antiseptically after death, neither bacteria nor their germs will be found; and hence that no bacteria-germs exist in living healthy organs. Messrs. Neucki and Gracosa, in order to prove the contrary, filled a large glass test-tube with mercury, closed it with a slip of glass, and inverted it in a vessel containing mercury. The vessel was then heated until the tube was one third filled with vapor of mercury. It was then allowed to cool; the quicksilver in the tube again condensed; and when that in the outer jar was heated to 120° it was covered with a five per cent. solution of carbolic acid. A portion of an internal organ from an animal recently killed was brought by means of a pair of tweezers under the mouth of the tube, up which it ascended. The apparatus was kept for several days at a temperature of 40°; and bacteria were subsequently found in the specimen. All experiments of this kind led to the conclusion that bacteria exist in the organs of living healthy animals.

Antiquity of Man.—Professor Boyd Dawkins, in a paper on the antiquity of man, read before the Sheffield meeting of the British Association, said that when he examined the great divisions of the Tertiary period in their relation to the highest forms of life, he was confronted by the following important facts: In the Eocene age there was not a single species of placental mammal. There is not a single well-authenticated case of any mammalian species, now living on the earth, having lived in the Miocene age, although the French archæologists claim that man lived then. In the Pliocene age one or two living species make their appearance. Passing to the Pleistocene or Glacial period, living species are very abundant, extinct species are rare. It is in this period that man appears, over an extended area. He is a mere hunter, not a farmer or possessor of wild animals. The prehistoric period which succeeded the Pleistocene was characterized by the absence of the extinct species of mammalia, with the single exception of the Irish elk. At this

time, the domestic animals, the dog, sheep, horse, and various breeds of cattle appear, and are subject to man; and along with them there was the cultivation of the arts of agriculture. In conclusion, he claimed that hopes of fixing the exact antiquity of man would be vain, as there were intervals of the length of which we have no record; but he was certainly an inhabitant of the earth during the Glacial period.

Does Sargassum vegetate in the Open Sea?—In reply to the questions of a correspondent in "Nature," regarding sargassum, Mr. J. J. Wild gives the following information: While on board the Challenger, during her cruise in the North Atlantic in the year 1873, he had frequent opportunity for observing this alga, and more than once saw large patches of it extending from the vicinity of the vessel to a great distance. As regards the appearance of these sargassum patches, he quotes Sir C. Wyville Thomson, who says: "They consist of a single layer of feathery branches of the weed (*Sargassum bacciferum*), not matted, but floating nearly free of one another, only sufficiently entangled for the mass to keep together. Each tuft has a central brown, thread-like, branching stem, studded with round air-vesicles on short stalks, most of those near the center dead and coated with a beautiful netted white polyzoön. After a time vesicles so incrusted break off, and, when there is much gulf-weed, the sea is studded with these little separate white balls. A short way from the center toward the ends of the branches, the serrated, willow-like leaves of the plant begin, at first brown and rigid, but becoming further on in the branch paler, more delicate, and more active in their vitality. The young fresh leaves and air-vesicles are usually ornamented with the stalked vases of a *campanularia*. The general color of the mass of weed is thus olive in all its shades, but the golden olive of the young and growing branches greatly predominates." Mr. Wild still further quotes from the same author to the effect that sargassum is the "one notable exception" to the rule that the higher algæ do not live on the surface of the sea. Mr. H. N. Moseley, in "Notes by a Naturalist," refers to the pelagic habits of sargassum and other sea-weeds when he says, "They grow attached to rocks, as well as free, but they all produce spores only when attached."

The Salmon Industries of Oregon.—It is well known that the salmon, which is esteemed a luxury, and at certain seasons of the year is found only on the tables of the rich, is a prolific fish. A female will yield about a thousand eggs for every pound of her weight, but, of the millions of eggs deposited in spawning-beds, only a few develop to adult salmon. Numberless ova escape fertilization, floods carry them from their places of deposit, and enemies destroy both eggs and fish. Enthusiasts in fishery economy assert that in the near future salmon will be as cheap as other fish. At present, however, it is very dear, and, notwithstanding that artificial spawning is resorted to, the fish does not increase in proportion to the increasing demand. This keeps up the price, and has given rise to an important industry in the preparation of canned salmon. We glean the following concerning this industry from "Chambers's Journal": A surprising trade in this commodity has developed in Oregon, and large quantities of canned fish are exported from this source to Great Britain and Europe. Scotland and Ireland yield excellent salmon, but the canned fish may be obtained even in remote towns of the United Kingdom for half the price of the fresh. There are flourishing canneries on the Umpqua, Fraser, Royal, and Columbia Rivers. In some of these a capital of fifty thousand dollars has been invested, and twice that outlay will be required for some newly projected establishments. The fish taken from the Columbia River are nearly all 'canned,' and as many as twelve million pounds of salmon have been taken from this source in a single season. The Columbia is a river of vast extent, with an enormous body of water. Salmon run up to a distance of four hundred miles from the sea, and thus obtain ample living and spawning room in shallow places of the main stream and its tributaries. The fish selected for canning is locally known as the 'chinook salmon.' Its average size is twenty-two pounds. When taken only for local consumption, clubs and

spears, or hook and line, serve the purpose; but, in order to supply the now enormously increased demand, drift-nets are used. These are three quarters of a mile in length, twenty feet in depth, and have a mesh sufficient to allow the head of a fish to enter as far as the gills. The fishing-season lasts from April to July, and during this time the work is prosecuted with vigor. Everything required in the business is manufactured on the premises. Foreigners are employed to do the work; Italians capture the fish and Chinamen prepare it for consumption. The fish, placed in racks in quantities, at the entrance of the cannery, are readily accessible. A flexible water-pipe directs its searching flow of water on to the salmon to cleanse them, after which they are sorted and placed within reach of the first operator. He takes off head, fins, and tail; making an incision into the back, the intestinal matter is removed, and the fish thrown into a tub half filled with water. The second operator scrapes and washes it, and passes it on to man number three for inspection. The fourth person ranges the bodies in a trough, where by means of blades driven by a crank they are cut to pieces. These are now neatly packed in cans, a spoonful of salt is put into each one, the lid is soldered down, and the cans are then ready for the cooking-house. Here immersed in a huge steamer they cook an hour. Removed from the steam-bath, they have each a small hole bored in them, to admit of their quickly cooling. The tins are next placed in boiling salt water, where they remain two hours. They are again examined, now to see that the ends have assumed a concave shape. Such tins as have not taken this shape are condemned, while all others are passed forward to be varnished and labeled. Before being sent to market they are again examined, and imperfect cans are rejected.

Voice in Fishes.—Mr. S. E. Pool, in a late number of "Nature," gives an account of an interesting observation of his own in support of the claim that fishes possess a faculty of voice. He states that, when engaged in a survey of the "Disang River in eastern Assam" some six years ago, he had occasion to sound the depth of a pool. When seated in a small canoe and slowly nearing it, he suddenly became aware of the presence of a number of fish called "mahsir." They were evidently attracted by the canoe, and Mr. Pool surmised that they might possibly think it a huge dead fish. While watching their movements, he became "aware of a peculiar 'cluck' or percussive sound—frequently repeated, on all sides, and coming from below," but near by. This was soon traced to the mahsir, and one of them made distinct sounds which were answered by others. He further states that in some parts of eastern Assam a large bivalve sings in concert with others.

Expansion of Bodies by Electrification.—In a communication to the Paris Academy of Sciences, E. Duter describes some experiments which have led him to the conclusion that bodies are increased in bulk by electrification. A large thermometer-tube is filled with water and coated externally with tin-foil, forming a Leyden-jar or condenser, with the water for the interior conductor, the foil for the exterior conductor, and the tube for the insulator—a platinum wire dipping into the water as a charging rod or electrode. As soon as the jar is electrified the water sinks to a lower level, and so remains till the jar is discharged. The inference is, that the glass is dilated by electrification, and this inference is strengthened by the fact that the same effects are produced whatever be the nature of the armatures, whether tin-foil, water, saline or mercury solutions. To remove all doubts, M. Duter modified the apparatus by placing the tube (or Leyden-jar) in a closed envelope of glass, terminated also by a thermometer-stem and filled equally with a liquid conductor. In this arrangement the liquid of the internal reservoir formed the interior armature of the condenser, and the liquid of the envelope formed the exterior armature, the glass tube being, as before, the insulator. On electrification, while the inner liquid sank, the outer liquid rose to an equal amount, thus proving the accuracy of the inference. On discharge of the electricity, the original levels were restored. The conclusion is, that the internal capacity of a Leyden-jar and its external volume are increased by charging it with static electricity. Temperature can not cause this

change, since the effect is immediate in charging and discharging. Neither can electric pressure cause it, because that must be the same on both sides of the dielectric, and a diminution of volume would be the result. Again, it is not due to the polarity of the armature, for on reversing the poles the effect is the same.

Sheep poisoned at Pasture.—If we regard the masses of its bloom, and the exceptionally exquisite form of its blossoms, probably no flower can equal the kalmia, or American laurel. All this is appreciated in Europe, and the plant holds a distinguished place in its gardens. But at home this fine shrub bears the execration of all shepherds and herdsmen, as it is poisonous to the sheep. Next to Australia, if not equal, in sheep-raising, is Colorado. Unhappily, a poisonous mallow (*Malvastrum coccineum*) is found growing from Iowa across the great Plains westward. Last October a sheep-raiser named Ruble, in Pueblo, Colorado, had the ill luck to have a flock get into a patch of this terrible weed, and twelve hundred sheep perished in four hours! Another plant in Colorado, the dreaded "loco" of the stock-men—the *Oxytropis Lamberti*—is also noted for its poisonous qualities.

A Precocious Century-Plant.—There is now (January) a fine century-plant (*Agave Americana*) in full bloom, in the conservatory of John Hoey, Esq., at Hollywood, Long Branch, New Jersey. This plant is only twelve years old. The notion of this aloe only blooming when a hundred years old is simply a tradition of the elders. It all depends on the environment and chiefly temperature. Blooming at the age of fifty years is common. To get the plant into bloom at twenty-five years is considered quite satisfactory by the gardeners, but this instance of one flowering at twelve years, in a conservatory, must be accounted as unique.

The Proportion of Oxygen in the Upper Air.—Though oxygen is heavier than nitrogen, and therefore ought to fall to a lower level in the atmosphere than the latter gas, still, no difference has ever been found to exist in the relative proportions of the two, even at the greatest attainable altitudes. Up to such elevations the agitation of the air suffices to keep its components uniformly mixed. Whether there is any want of uniformity at still greater elevations is an open question, the solution of which has been attempted by Professor Edward W Morley, of Hudson, Ohio. Accepting as provisionally correct the theory proposed a few years ago by Professor Loomis, that great and sudden depressions of temperature are sometimes owing to the vertical descent of cold air from elevated regions of the atmosphere, Professor Morley inferred that samples of air taken at the earth's surface during a great and sudden lowering of temperature might have come from altitudes where the proportion of oxygen had been lessened by the action of gravity. He has therefore made numerous analyses of air during "cold waves," and the result has been invariably to show deficiencies in the proportion of oxygen in the air at such times.

New Coloring Matters.—The chemists Savigny and Colineau have discovered a method of obtaining innocuous coloring matters from the red cabbage. This substance is known as cauline, and is useful in painting, for printing fabrics, and for dyeing. The process is as follows: Cut the interior of the cabbage and the stalks of the leaves in small pieces and place them in boiling water in the proportion of one and a half kilogramme of leaves to three litres of water. The infusion is left about twenty-four hours to macerate, then the leaves are taken out and submitted to pressure to squeeze out the water, which is added to the liquid infusion; this cauline is of a violet-blue color. It forms the base of a series of derivatives which constitute the precipitates of various colors. For instance, to obtain *barucauline*, two grammes of baryta are added to five hundred grammes of cauline cold; this produces a clear green dye. To obtain *chlorocalcicauline*, which is a bluish green, one hundred grammes of anhydrous chloride of calcium are added to half a kilogramme of cauline. A false bronze color is obtained by adding one hundred to five hundred grammes chloride manganese and five grammes baryta to five hundred grammes cauline; this is called *mangocau-*

line. Zincocarbocauline, which is an ultramarine blue, is obtained by introducing forty grammes chloride zinc and twenty-five grammes carbonate soda to five hundred grammes cauline.

NOTES.

EXTENSIVE excavations near Waldorf, in the neighborhood of Bonn, Germany, have brought to light the site of an old town believed to be of Roman origin, but the extent of which is yet quite unknown. The remains of a large Roman villa were discovered in the vicinity, situated a little below the site of an extinct volcano—a circumstance going to show that at the time of the Roman occupation the volcanoes of the Rhine had ceased to be dangerous.

JAMES CLERK MAXWELL, the distinguished Professor of Experimental Physics at the University of Cambridge, and the author of numerous works on physics, died at Cambridge, November 5, 1879, at the early age of forty-eight years.

A CASE of serious injury to the eyes, by the use of chloral, is given in a late number of the "Medical Record," on the authority of Dr. G. H. Felton, of Haverhill, Massachusetts. The Doctor writes that the drug was administered for a few days only, and apparently in the usual small doses. It caused severe pain in the eyes, obliged retirement to a darkened room for several days, and left a condition of weakness that has persisted for two years, and that still necessitates the occasional use of colored glasses.

BY the death of Dr. Karl Friedrich Mohr, of Bonn, the science of chemistry has lost a worker whose valuable labors have extended over half a century. He was born in Coblenz, in November, 1806, and will be best remembered by the "Lehrbuch der chemisch-analytische Tetrirmethode," which appeared in 1855 and 1856. His published papers are mainly those devoted to meteorology and those bearing on volumetric analysis. Among the various subjects treated by him are ground-ice, ozone, St. Elmo's fire, lightning-conductors, hail, and rain. His various papers on chemical analysis extend over a period of fifty years.

THE Brussels International Congress for Commercial Geography passed, among others, the following resolutions: "1. The Congress is of opinion that, in the interest of all nations, it is desirable that one or more lines of railway should connect the coasts of Africa with its interior. 2. Complete freedom of trade should reign there. 3. In the expectation of a complete abolition of custom-houses, it is desirable that as many commercial treaties as possible should be concluded. It is particularly necessary that a treaty of this kind should be preliminarily entered into between Belgium and Holland. 4. The Congress expresses the wish that everywhere instruction in history should be separate from that in geography."

DIED September 13, 1879, William W. Saunders, F. R. S., F. L. S., etc., of London. He was chiefly interested in natural history pursuits, giving special attention to botany and entomology, and was three times elected President of the Entomological Society of London. His natural history collections were extensive, and especially his cabinet of insects, which at one time was considered the most complete in England.

STELLAR'S manatee, which is supposed to have become extinct in 1786, has until recently been represented in Europe by only a few bones preserved in the museum at St. Petersburg. During his recent voyage Professor Nordenskiöld obtained numerous remains of the animal in the neighborhood of Behring Strait.

THE death is announced of Lady Lubbock, the wife of Sir John Lubbock, on October 30, 1879. Besides a warm interest in her husband's scientific pursuits, Lady Lubbock was herself an occasional contributor to scientific journals, and among others published several years ago a paper of much interest on the "Shell-Mounds of Denmark," which attracted wide attention.

THE Council for the Royal Society has awarded, this year, the following medals: "The Copley medal to Professor Rudolph J. E. Clausius, of Bonn, for his well-known researches upon heat; the Davy medal to Mr. P. E. Lecoy de Boisbaudran, for his discovery of gallium; a Royal medal to Mr. William Henry Perkin, F. R. S., for his synthetical and other researches in organic chemistry; and a Royal medal to Professor Andrew Crombie Ramsay, F. R. S., for his long-continued and successful labors in geology and physical geography.

THE Apennine Railway reaches its highest point at an elevation of 2,000 feet above sea-level; the Black Forest Railway ascends to 2,762 feet, the Semmering line to 2,892 feet, the Caucasus line to 3,168 feet. The St. Gothard Tunnel is 3,750 feet above sea-level; the railway across the Brenner reaches 4,443 feet; the Mont Cenis Railway ascends to 4,348 feet, the North Pacific line to 5,369 feet, the Central Pacific to 6,121 feet, and the Union Pacific to 8,167 feet. The highest is the line across the Andes, which reaches an elevation of 15,500 feet.

CARL RITTER.